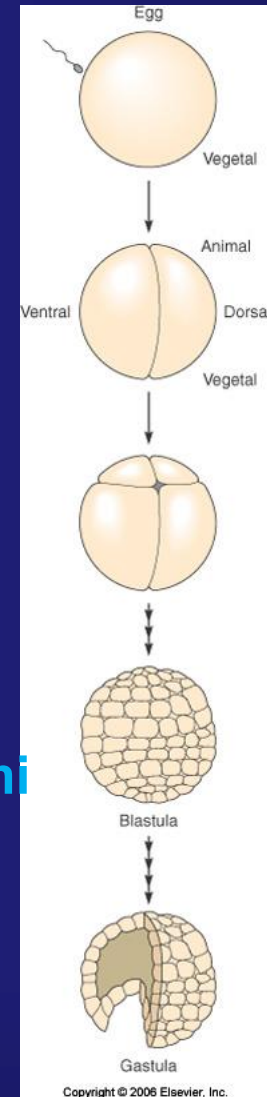
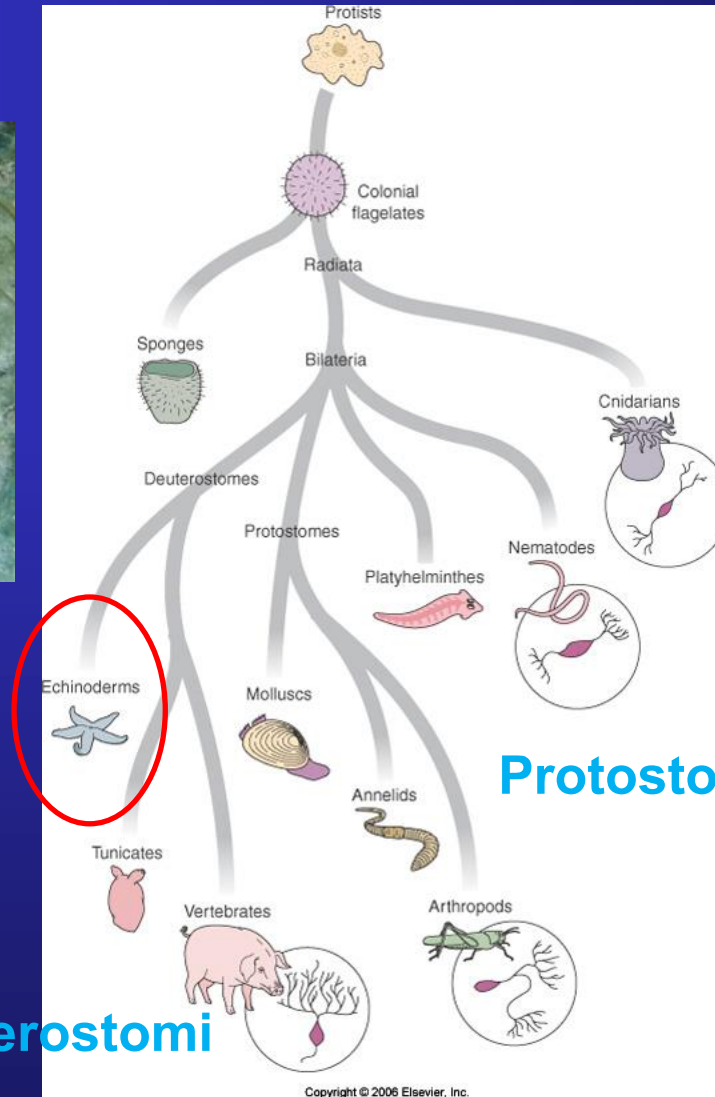
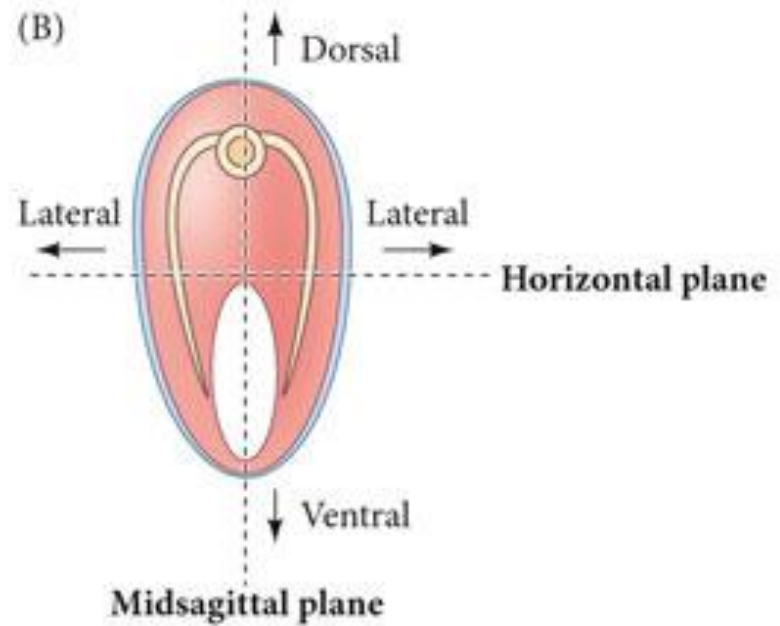
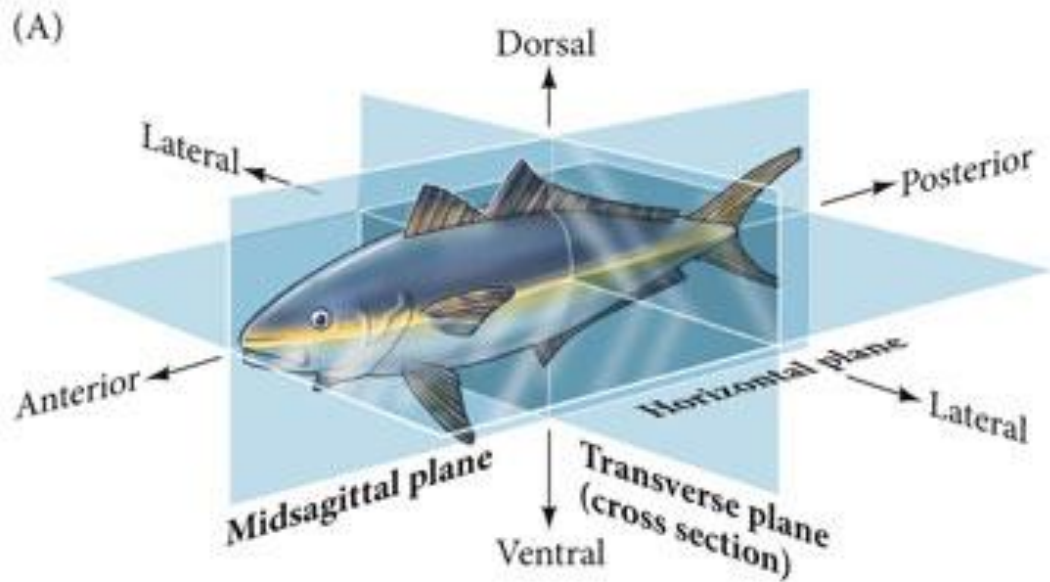
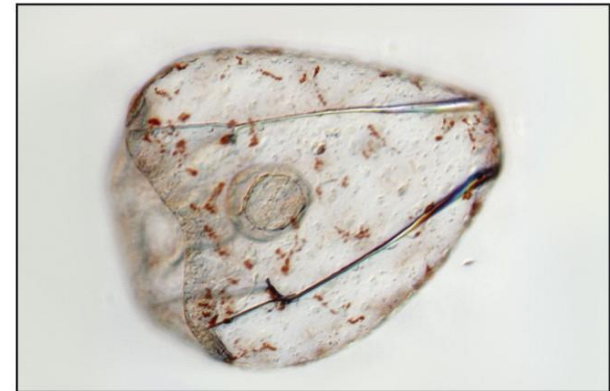
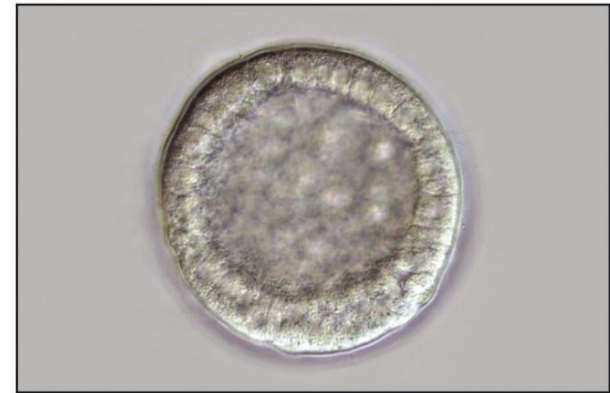
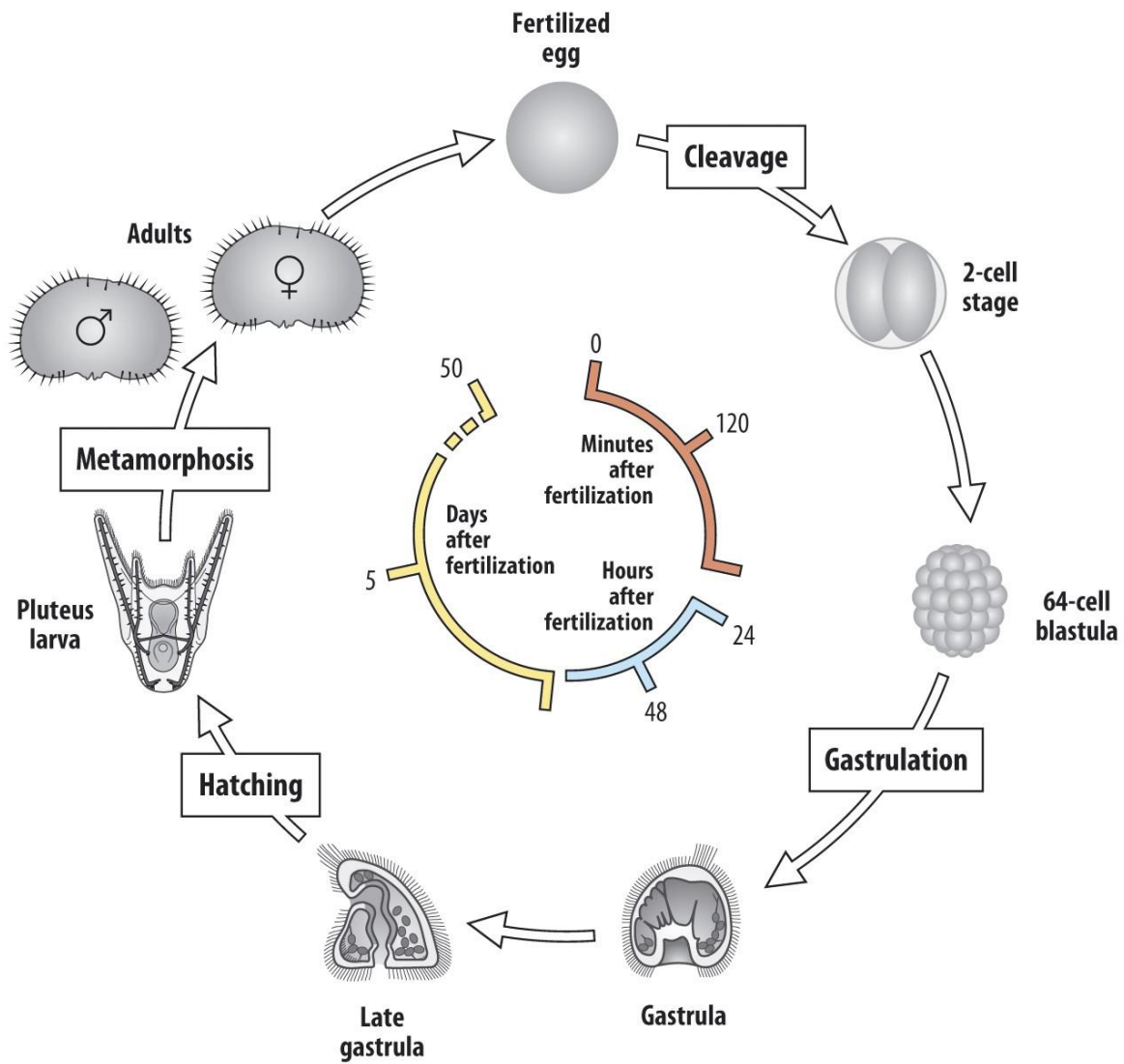


# SVILUPPO PRECOCE DEL RICCIO DI MARE

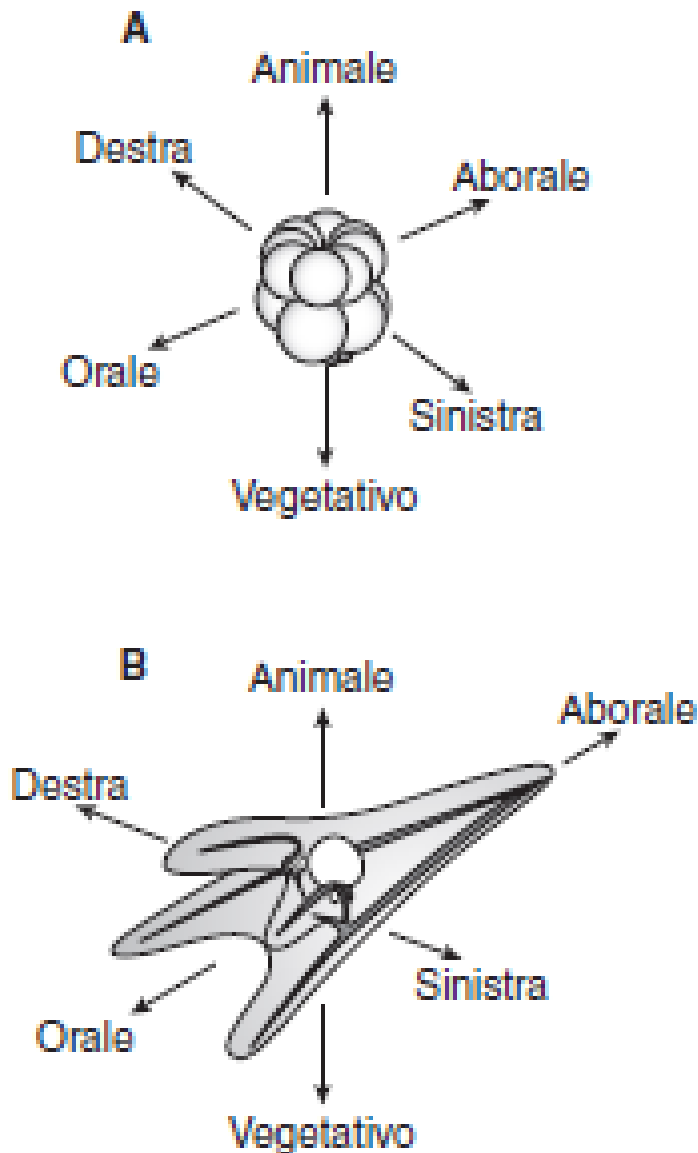


**Protostomi: nel canale alimentare si forma prima la bocca**  
**Deuterostomi: nel canale alimentare la bocca si forma per ultima**





## L'embrione di riccio di mare presenta degli assi di polarità'



**Inoltre, presenta altre caratteristiche che lo rendono un valido organismo modello in biologia dello sviluppo:**

**sviluppo embrionale esterno**

**elevato numero di gameti e di embrioni che si possono far sviluppare in modo sincronizzato**

**tempi brevi di sviluppo (48 ore)**

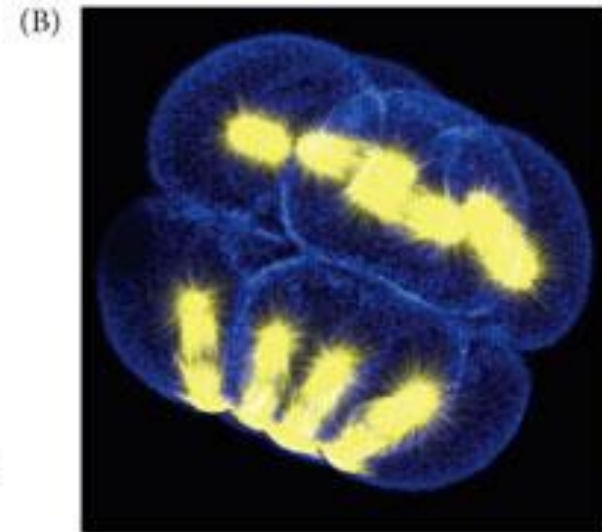
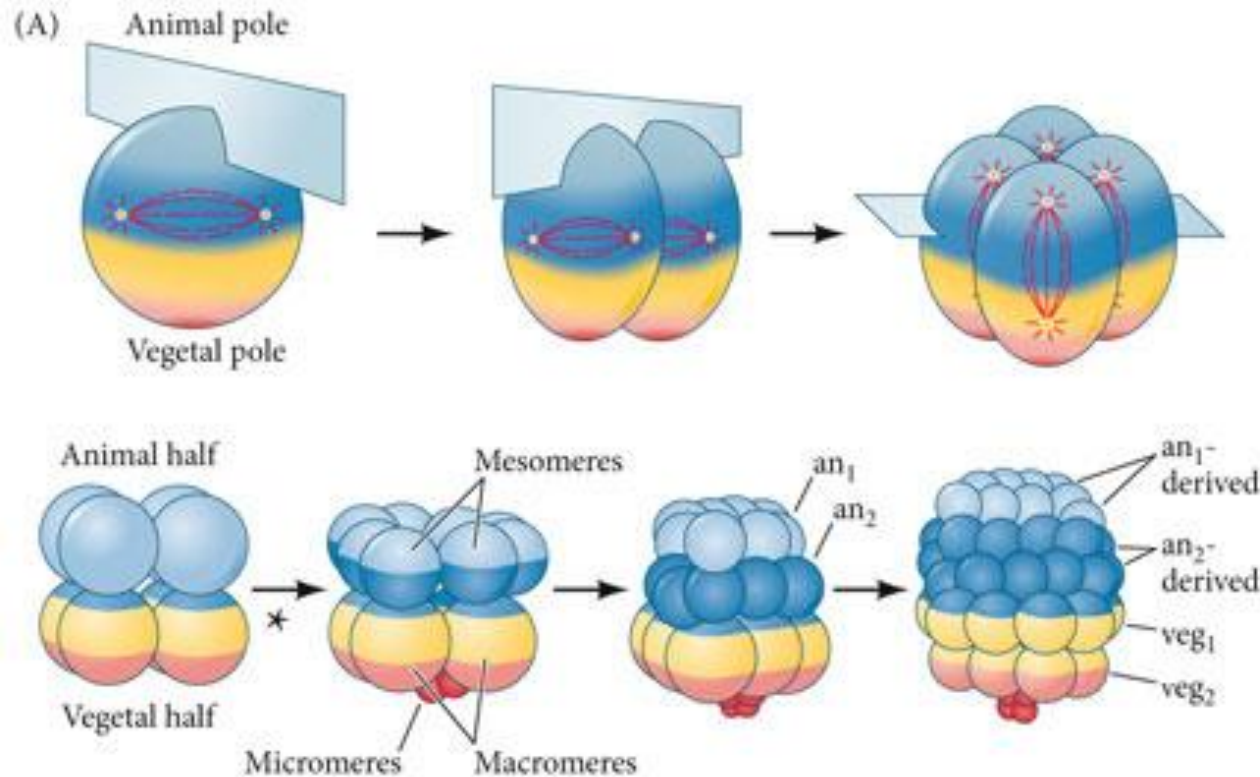
**embrione trasparente**

**facile manipolazione**

**Figura 9**

# SEGMENTAZIONE

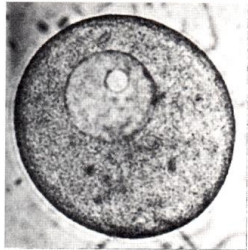
Uovo oligolecitico – Segmentazione oloblastica radiale subeguale



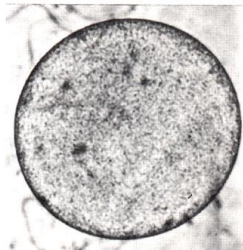
**Notare la posizione e orientamento dei fusi mitotici!**

DEVELOPMENTAL BIOLOGY 11e, Figure 10.2

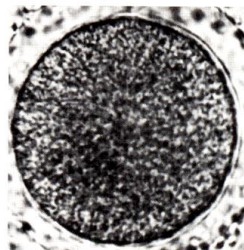
© 2016 Sinauer Associates, Inc.



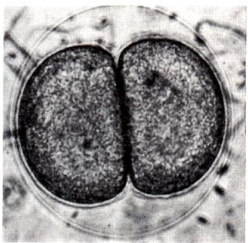
Ovocyte



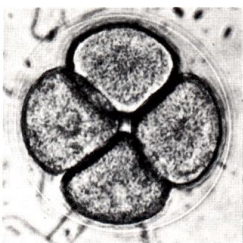
œuf mûr



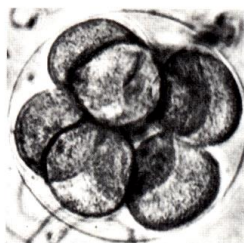
œuf fécondé



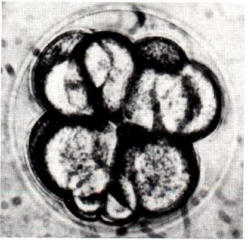
2 cellules



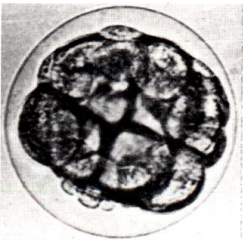
4 cellules



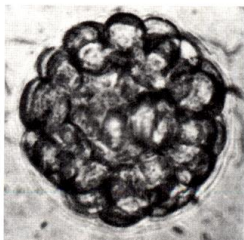
8 cellules



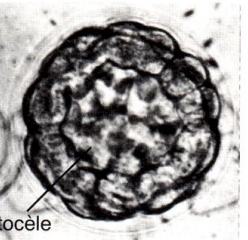
16 cellules



32 cellules

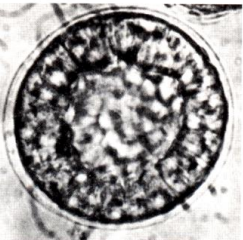


Morula

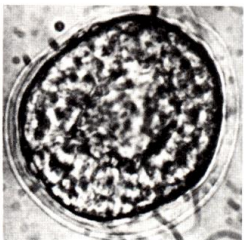


Blastocèle

Jeune blastula



Blastula



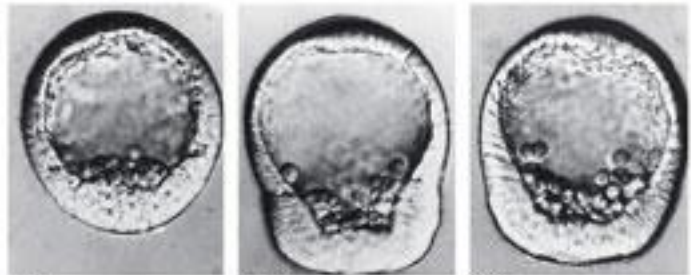
Blastula à l'éclosion

Mesomeri



Macromeri

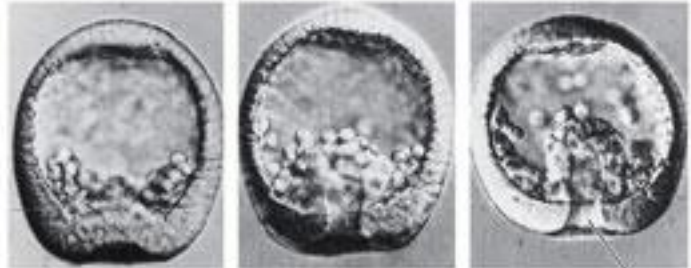
Micromeri



9 hr

9.5 hr

10 hr



10.5 hr

11 hr

11.5 hr

Blastopore



12 hr

13 hr

13.5 hr

Syncytial cables



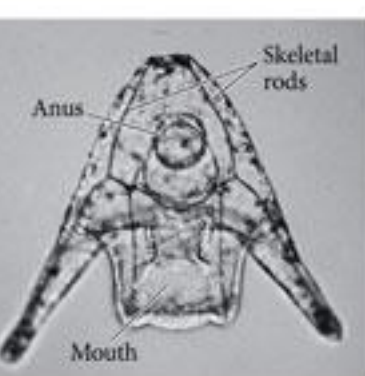
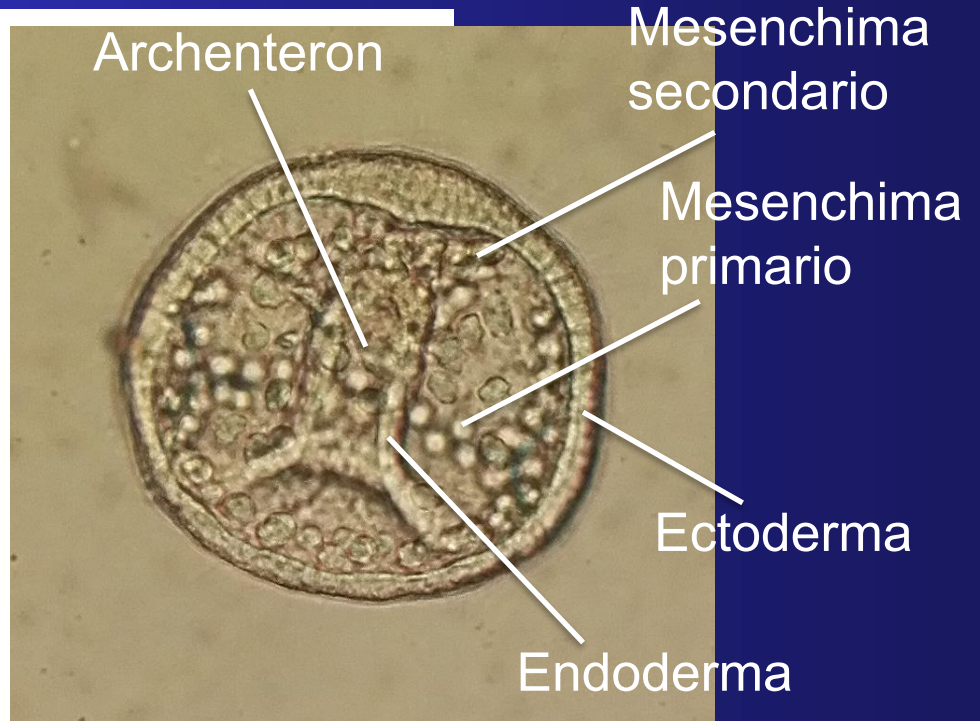
15 hr

17 hr

18 hr

Blastopore

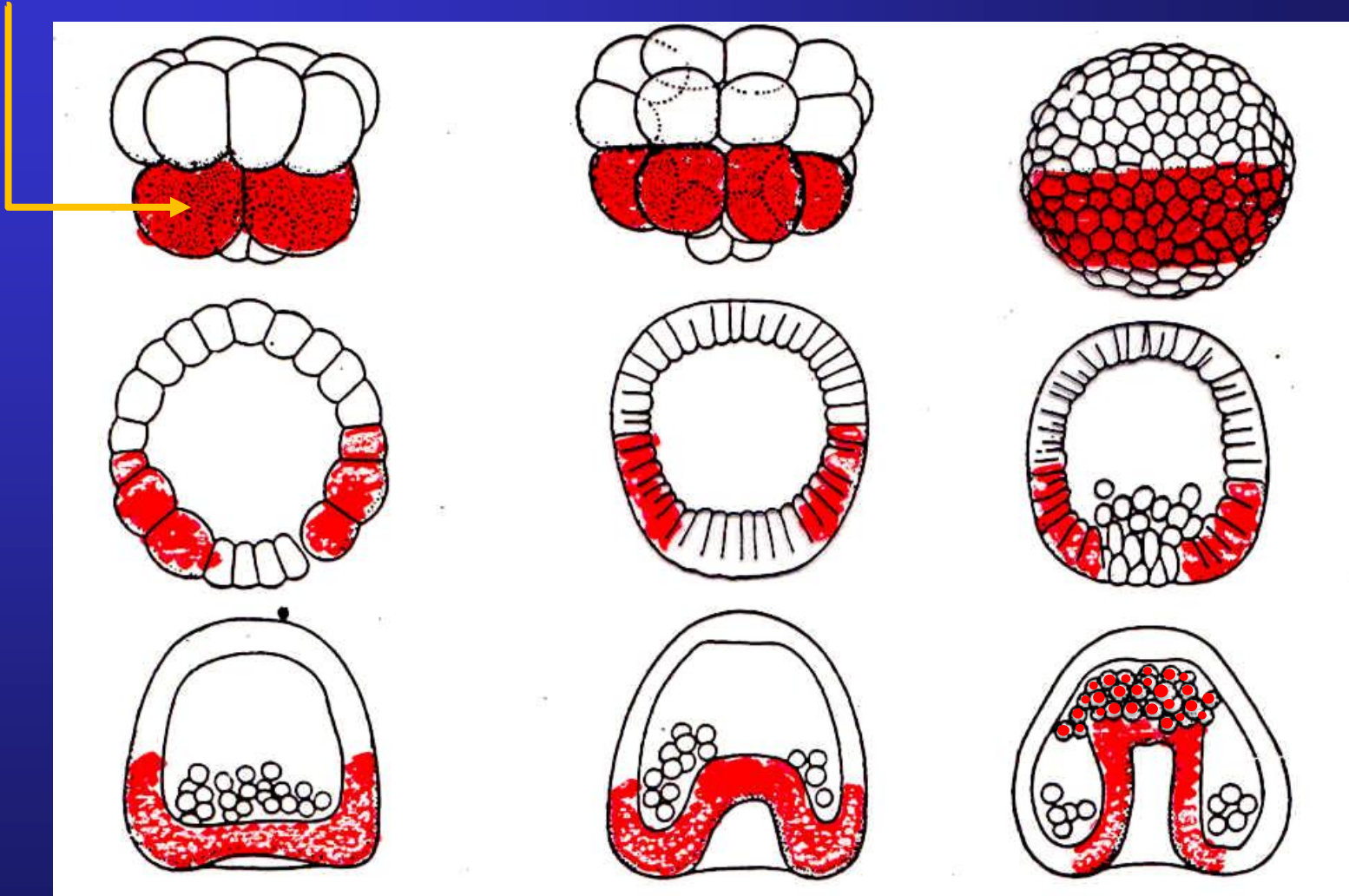
Syncytial cables



24 hr

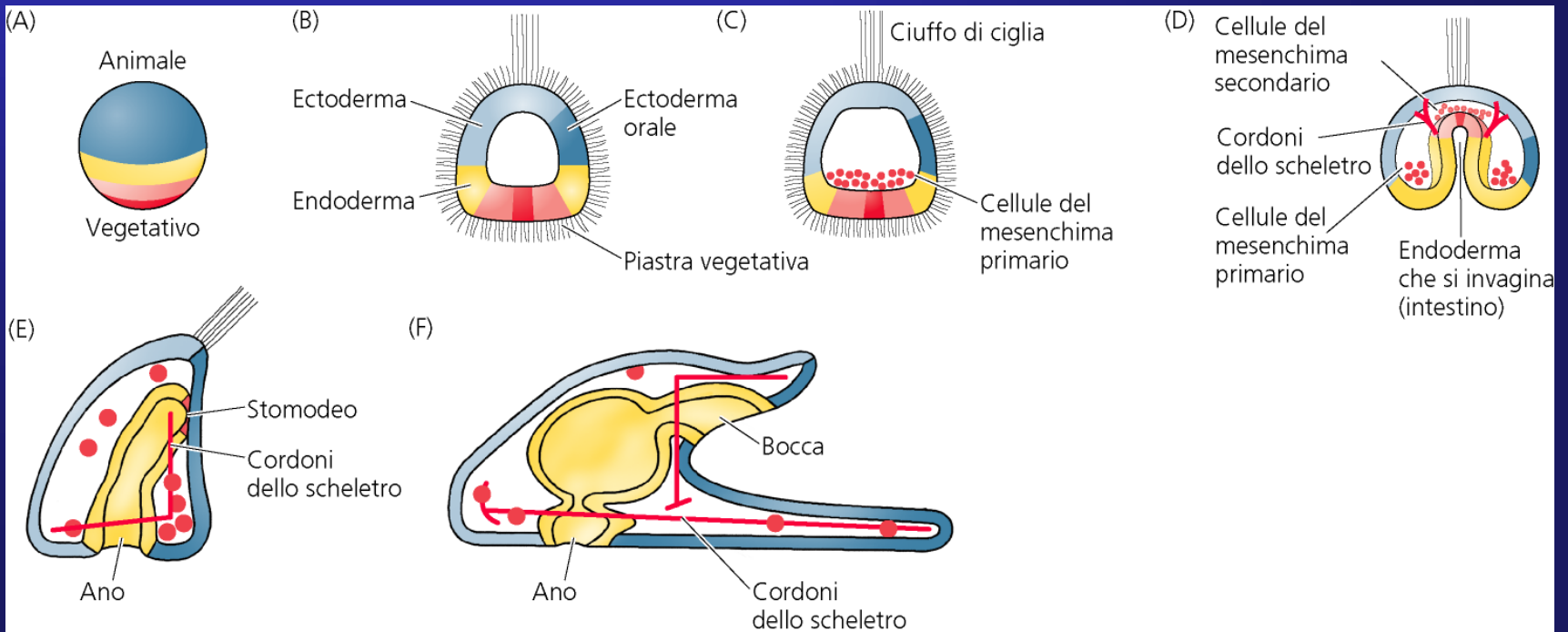
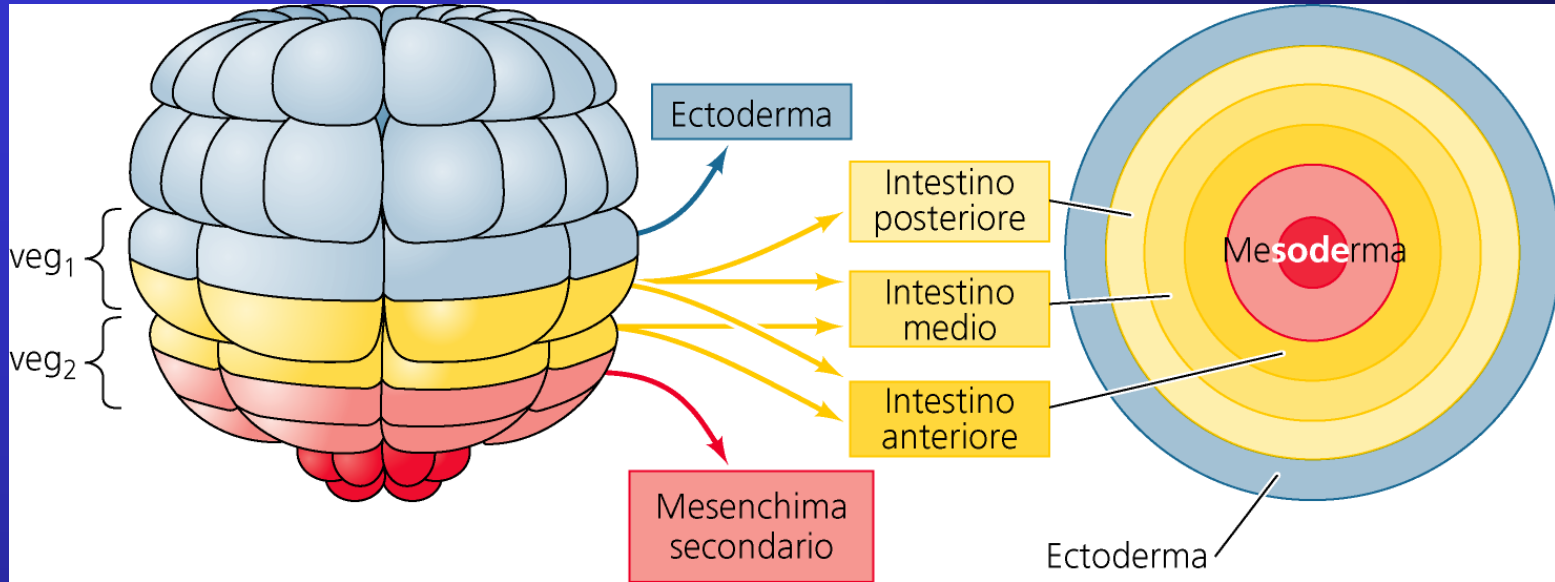
DEVELOPMENTAL BIOLOGY 11e, Figure 10.10  
 © 2016 Sinauer Associates, Inc.

## Iniezione di colorante vitale nei macromeri

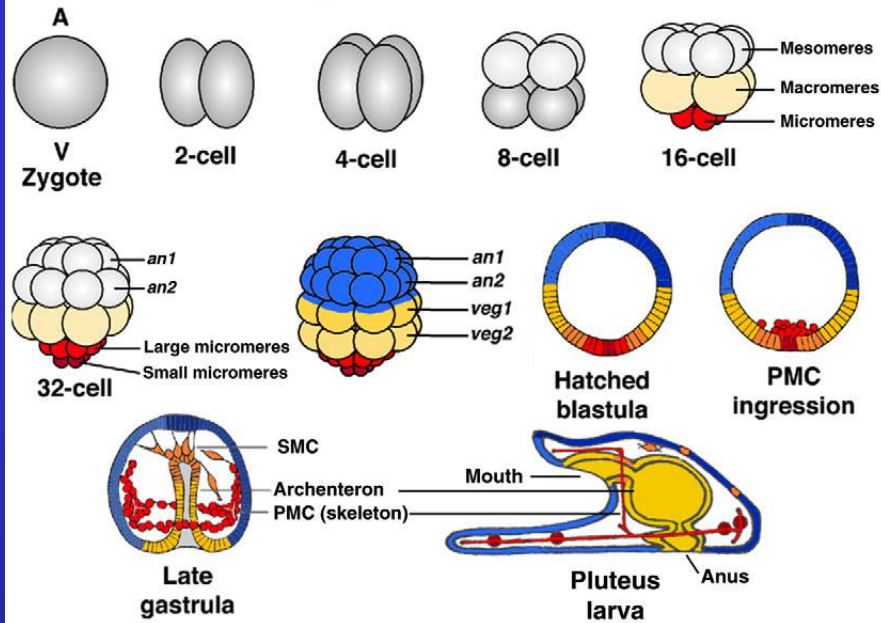


La colorazione si ritrova nell'endoderma e nel mesenchima secondario della larva

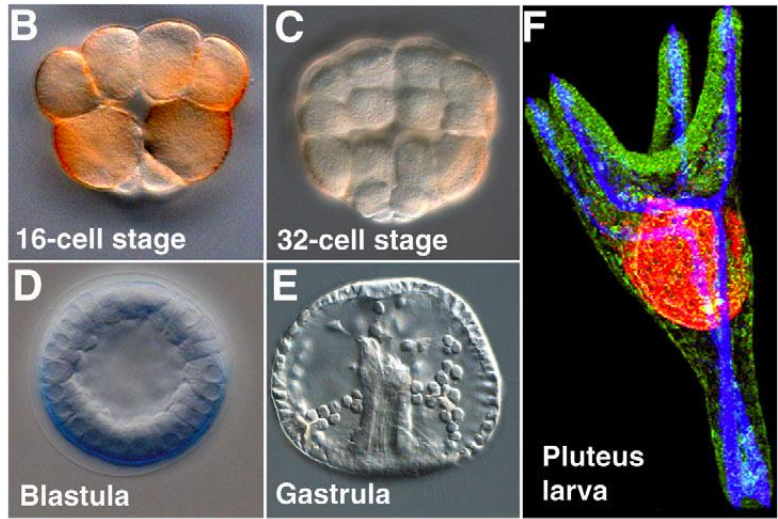
# Mappa dei territori presuntivi



# A Sea urchin development

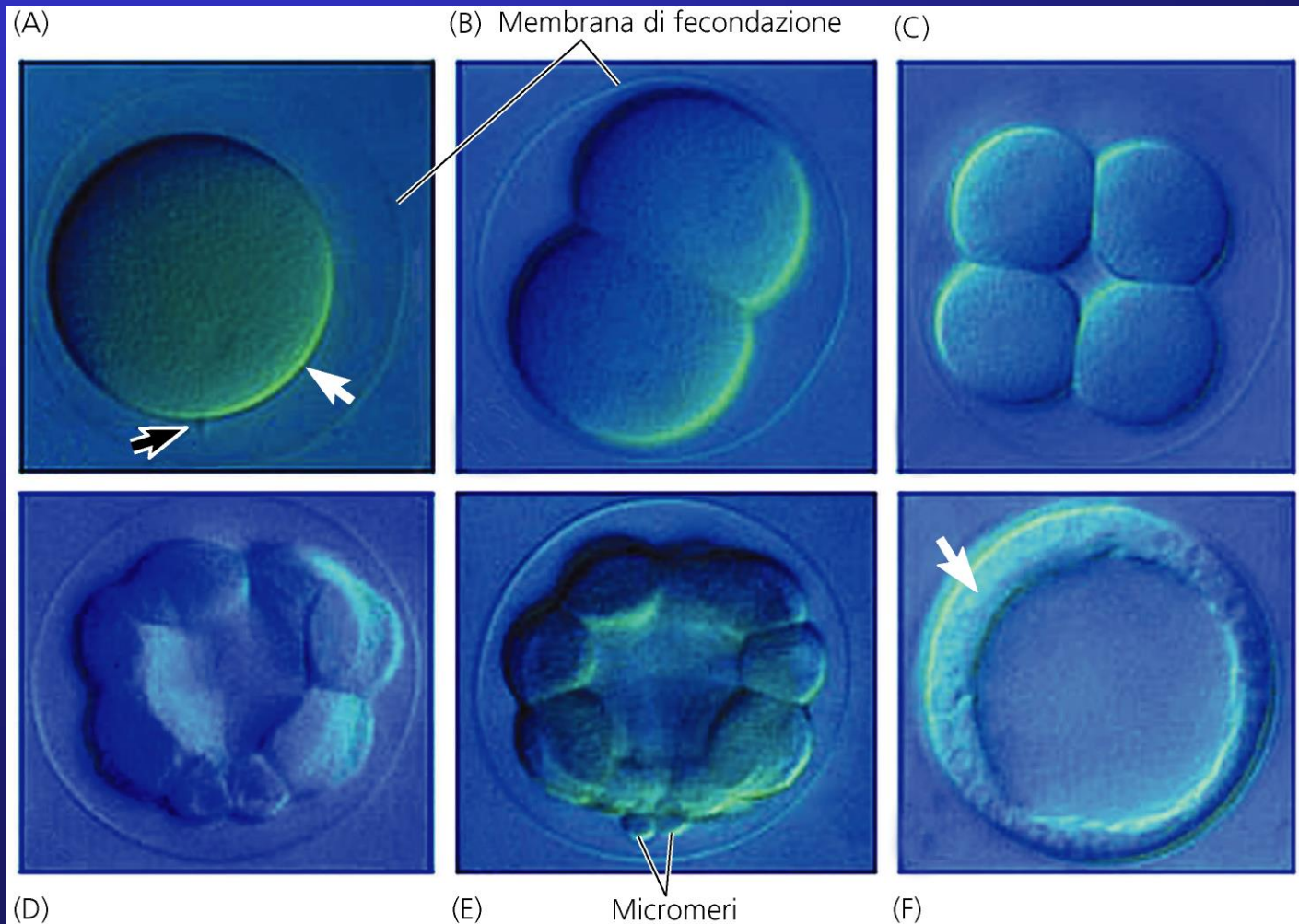


<b>Color key</b>	<span style="color: blue;">■</span> Ectoderm	<span style="color: red;">■</span> Skeletogenic mesoderm
	<span style="color: yellow;">■</span> Endoderm	<span style="color: orange;">■</span> Non-skeletogenic mesoderm







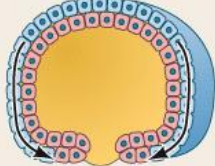
## ***Formazione blastocele***

- Alta affinità tra i blastomeri
- Deposizione di proteoglicani nella cavità blastocelica
- Forza centrifuga che determina il progressivo allontanamento dei blastomeri.



# Gastrulazione

TABLE 1.1 Types of cell movement during gastrulation<sup>a</sup>

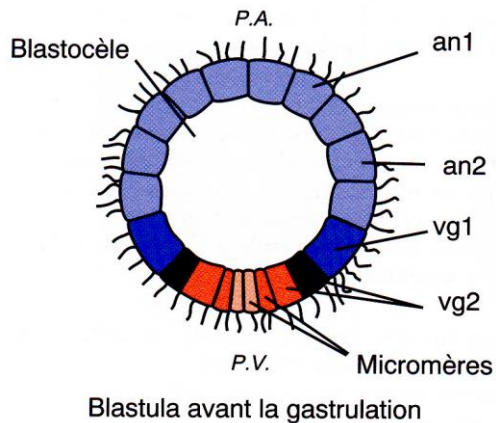
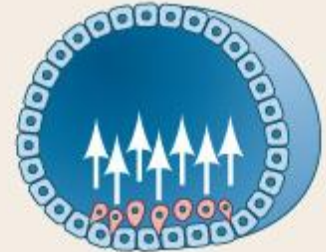
Type of movement	Description	Illustration	Example
Invagination	Infolding of a sheet (epithelium) of cells, much like the indentation of a soft rubber ball when it is poked.		Sea urchin endoderm
Involution	Inward movement of an expanding outer layer so that it spreads over the internal surface of the remaining external cells.		Amphibian mesoderm
Ingression	Migration of individual cells from the surface into the embryo's interior. Individual cells become mesenchymal (i.e., separate from one another) and migrate independently.		Sea urchin mesoderm, <i>Drosophila</i> neuroblasts
Delamination	Splitting of one cellular sheet into two more or less parallel sheets. While on a cellular basis it resembles ingression, the result is the formation of a new (additional) epithelial sheet of cells.		Hypoblast formation in birds and mammals
Epiboly	Movement of epithelial sheets (usually ectodermal cells) spreading as a unit (rather than individually) to enclose deeper layers of the embryo. Can occur by cells dividing, by cells changing their shape, or by several layers of cells intercalating into fewer layers; often, all three mechanisms are used.		Ectoderm formation in sea urchins, tunicates, and amphibians

<sup>a</sup> The gastrulation of any particular organism is an ensemble of several of these movements.

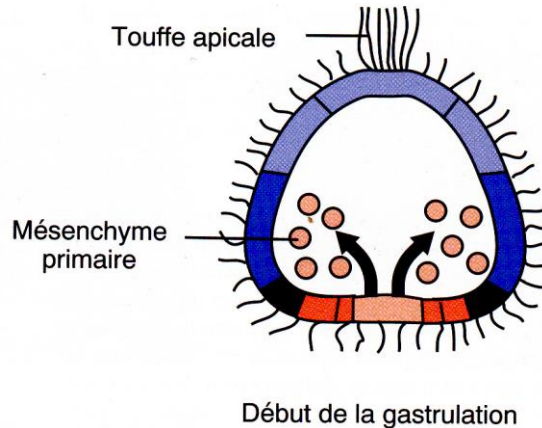
# Ingressione o immigrazione

## Ingression

Migration of individual cells from the surface into the embryo's interior. Individual cells become mesenchymal (i.e., separate from one another) and migrate independently.



Blastula avant la gastrulation



Début de la gastrulation

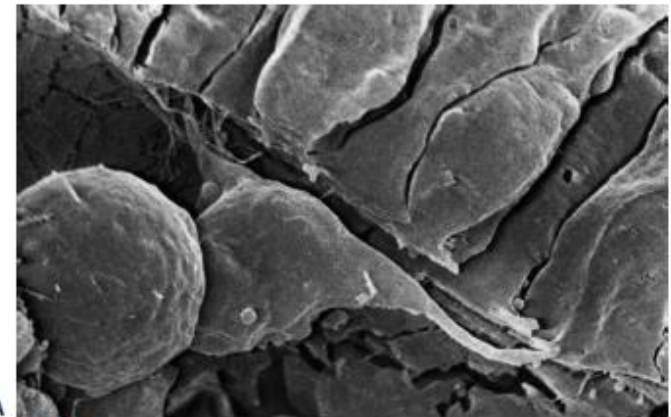
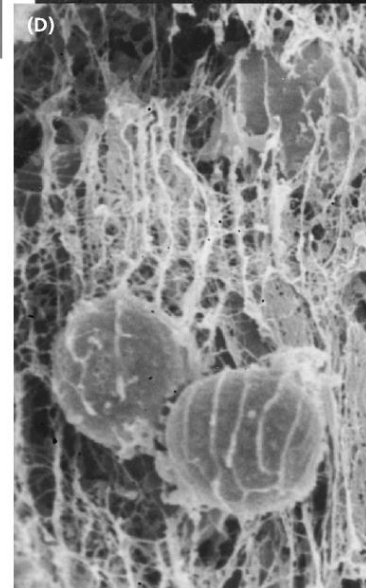
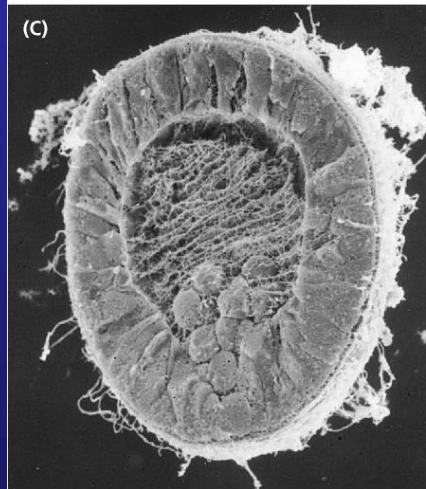
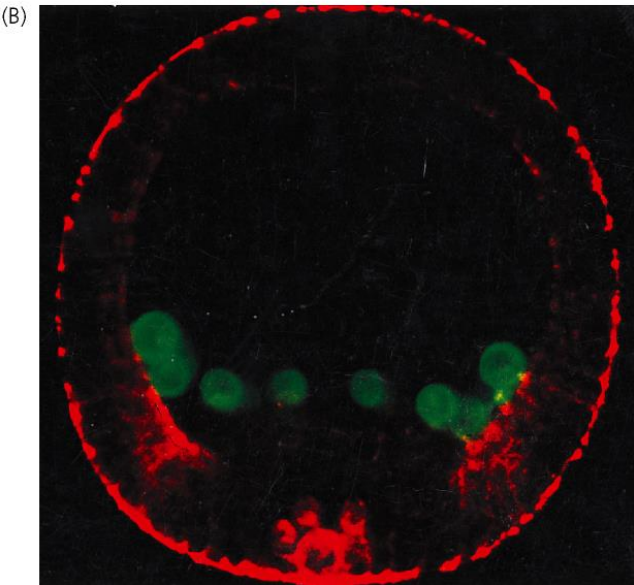
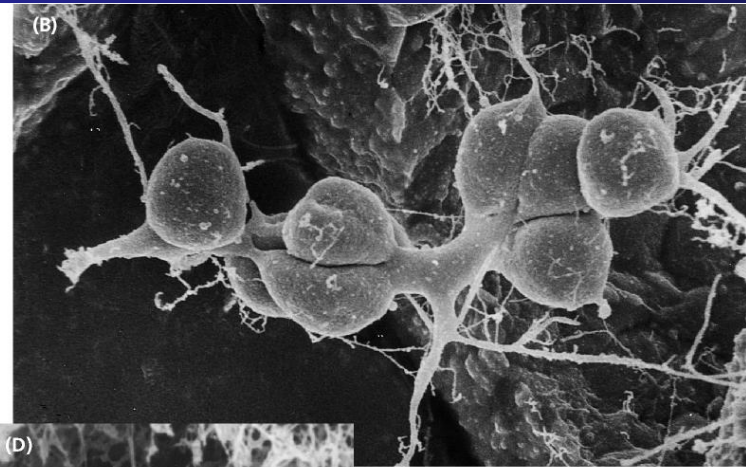
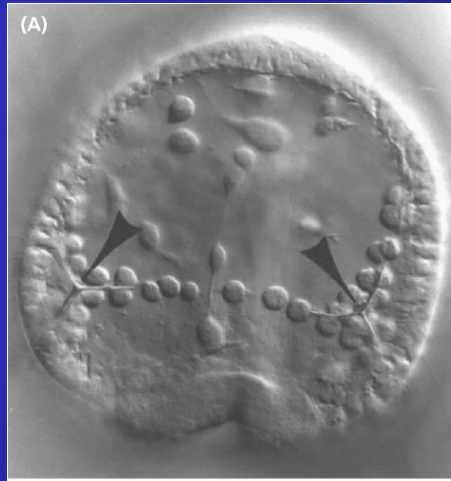
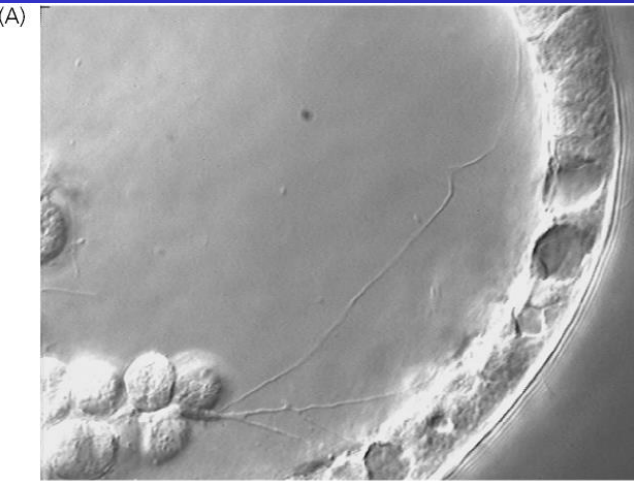


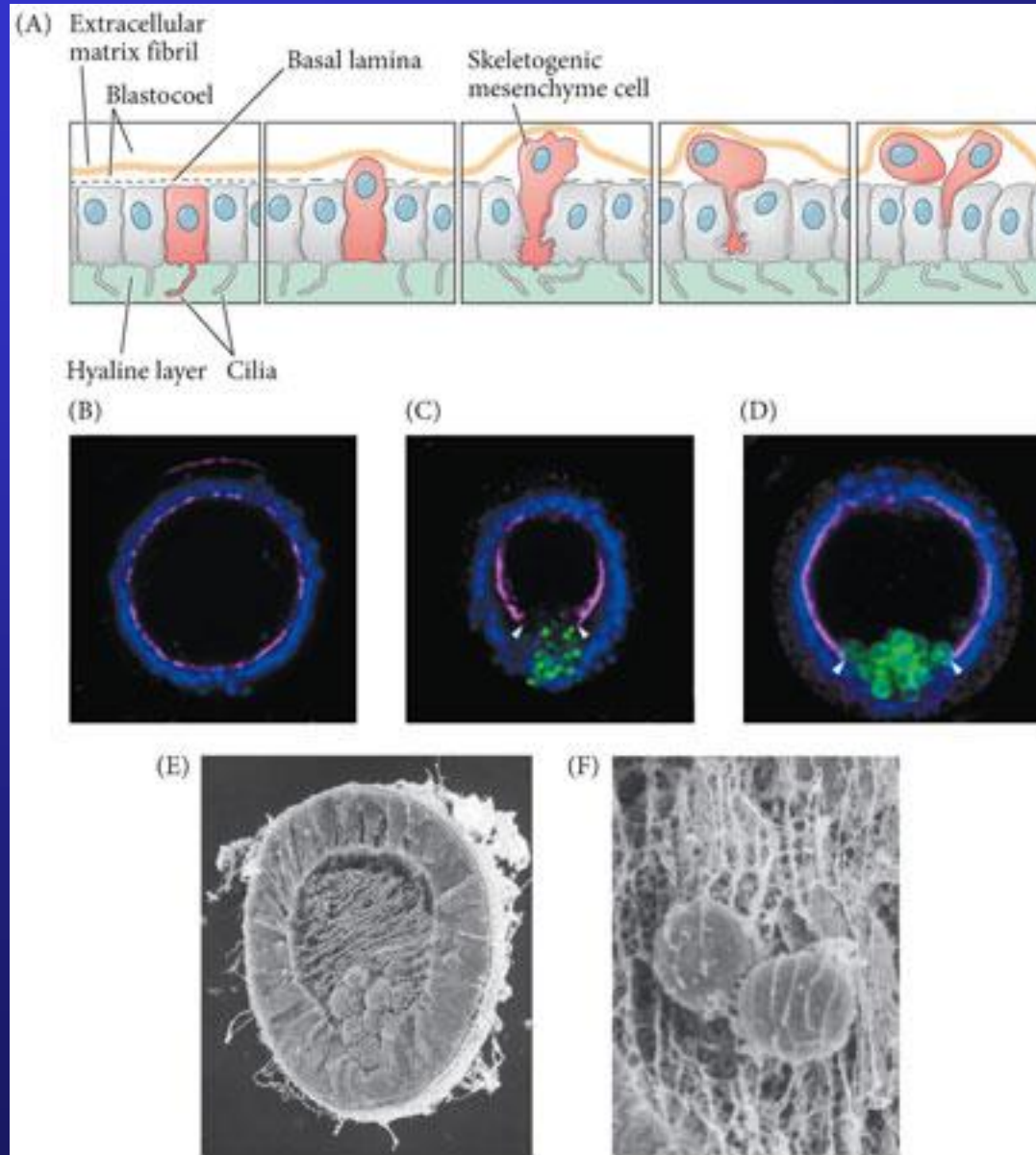
Figura 5

Mesenchima primario → Scheletro calcareo della larva



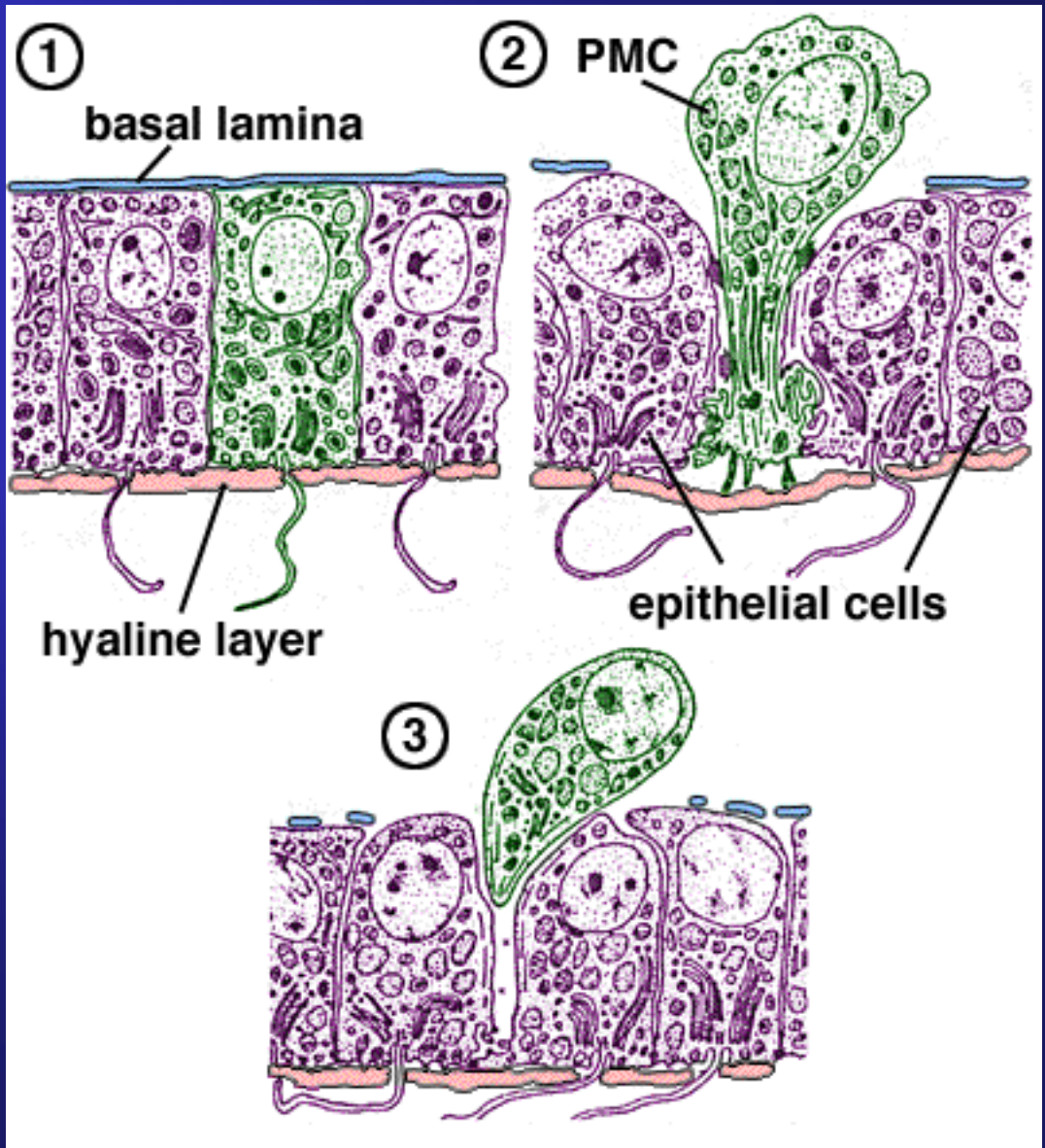
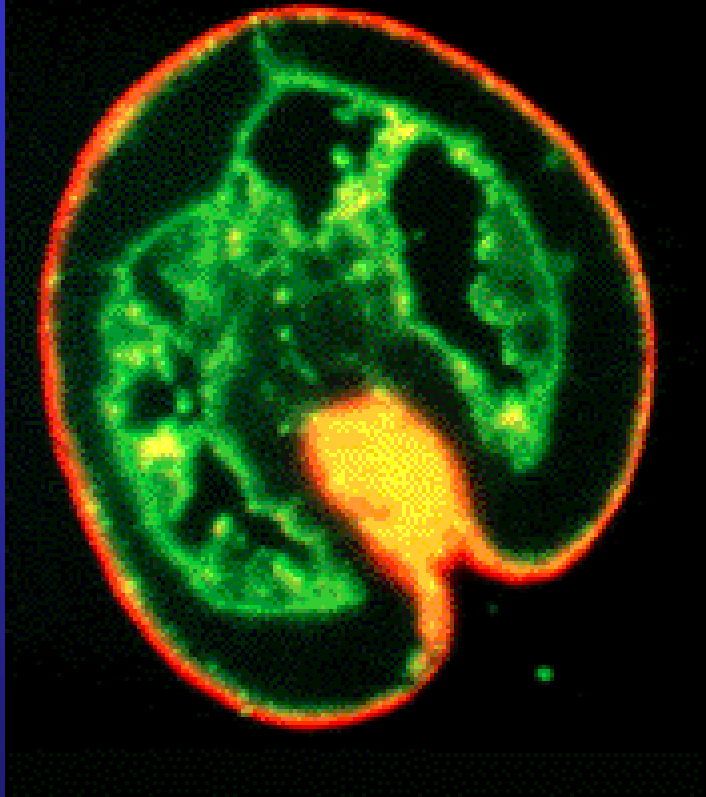


# Ingressione o immigrazione

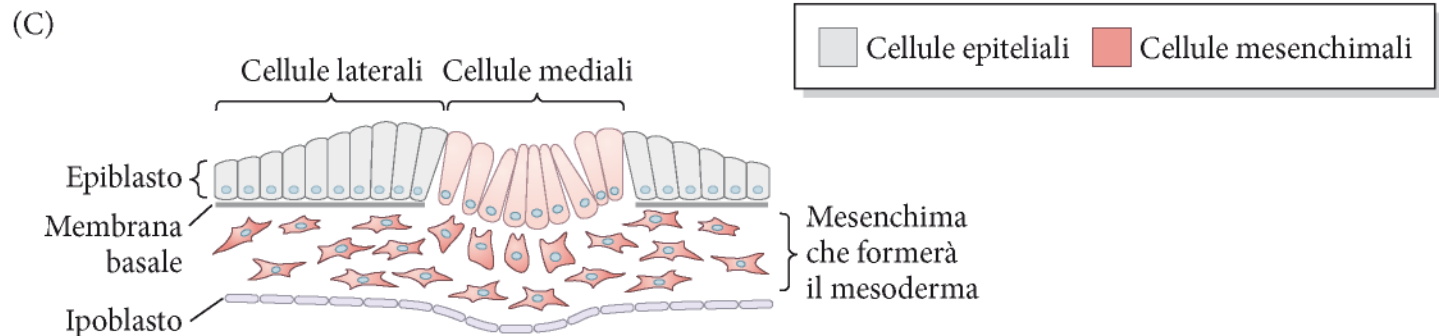
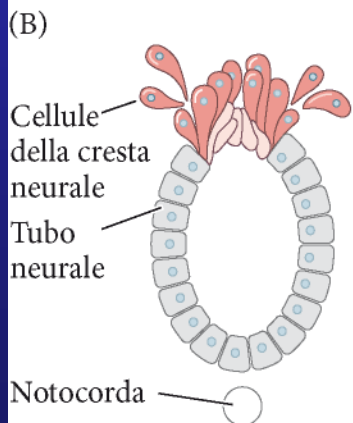
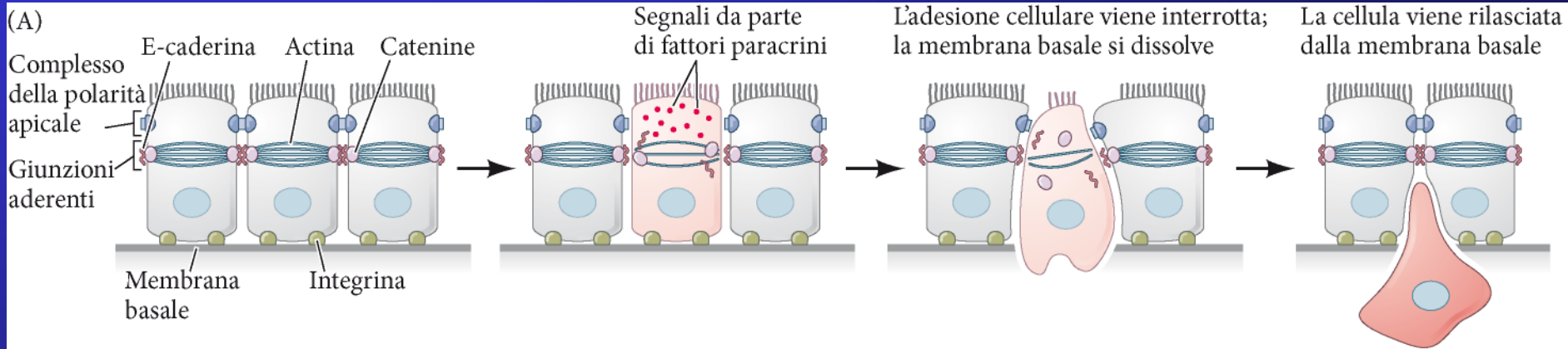


- Ridotta affinità tra i blastomeri
- Ridotta affinità per lo strato ialino
- Aumentata affinità per le proteine del blastocele

# ECM in the sea urchin embryo



# TRANSIZIONE EPITELIO-MESENCHIMATICA: meccanismo alla base del movimento di ingressione



**I MOVIMENTI DI IMMIGRAZIONE SONO MEDIATI DA INTERAZIONI  
CON LA MATRICE EXTRA-CELLULARE PRODotta DALLE CELLULE  
CHE RIVESTONO IL BLASTOCELE**

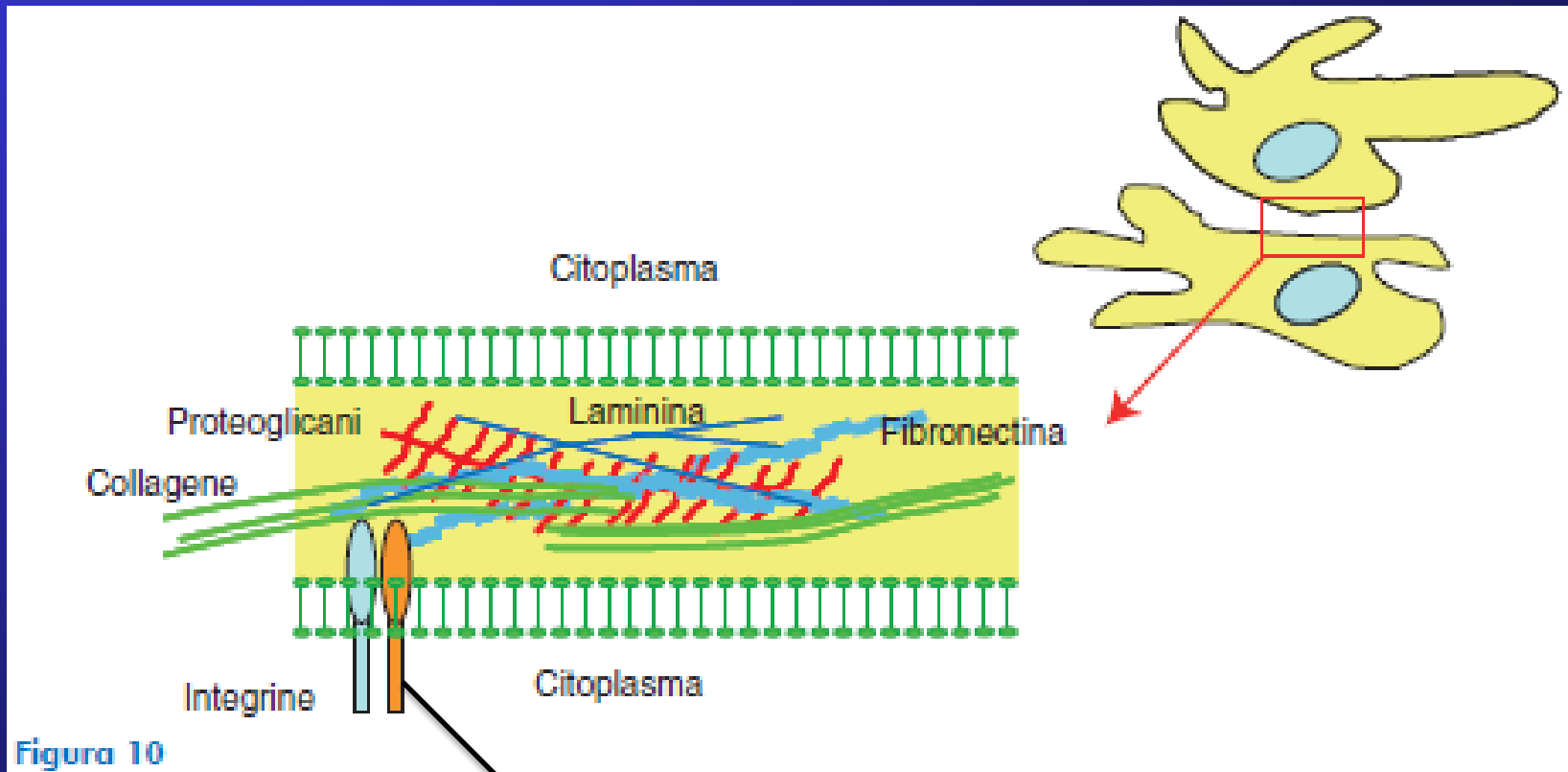
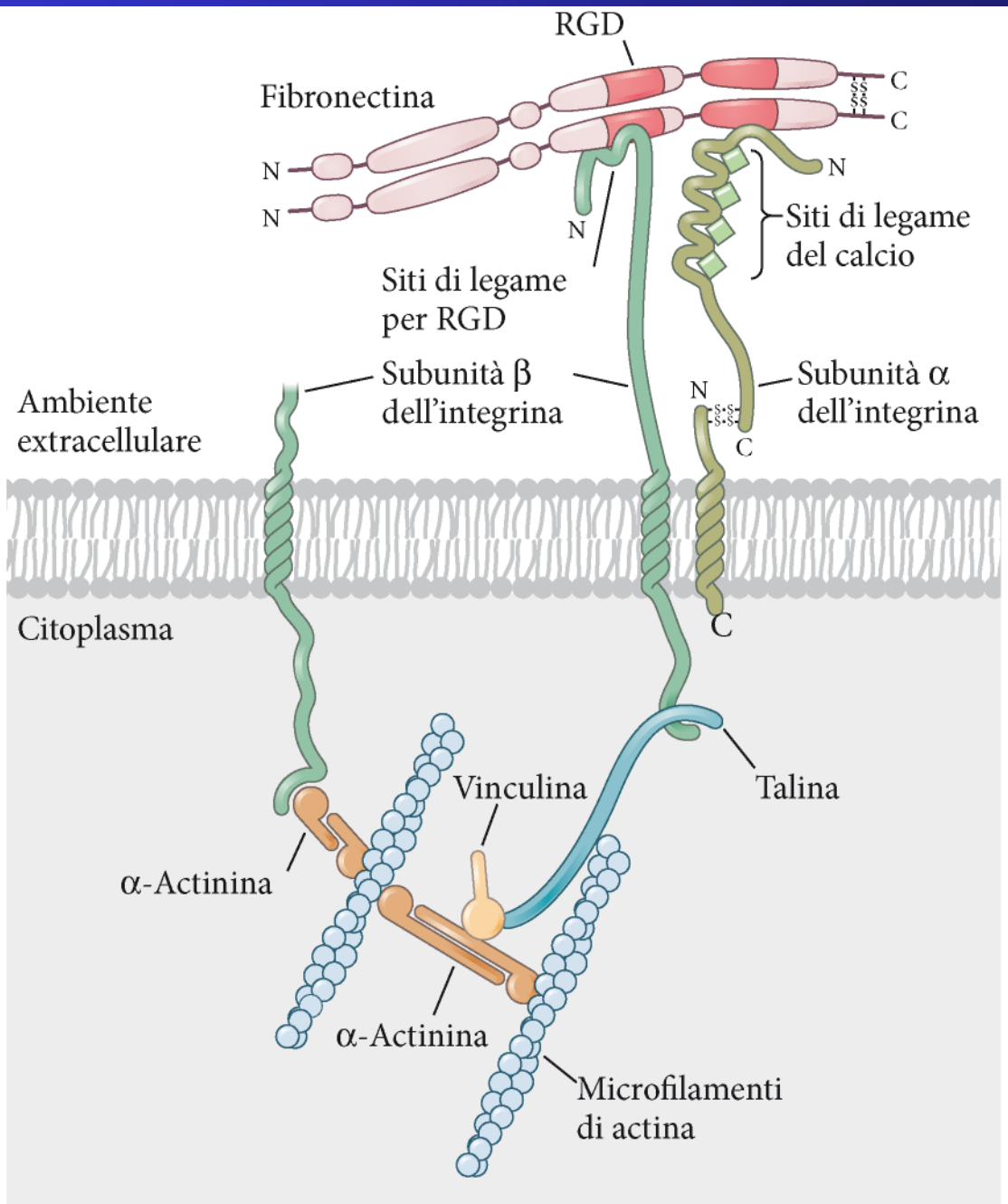


Figura 10

**LE CELLULE MESENCHIMATICHE MIGRANTI ESPRIMONO  
INTEGRINE SULLA MEMBRANA CELLULARE**



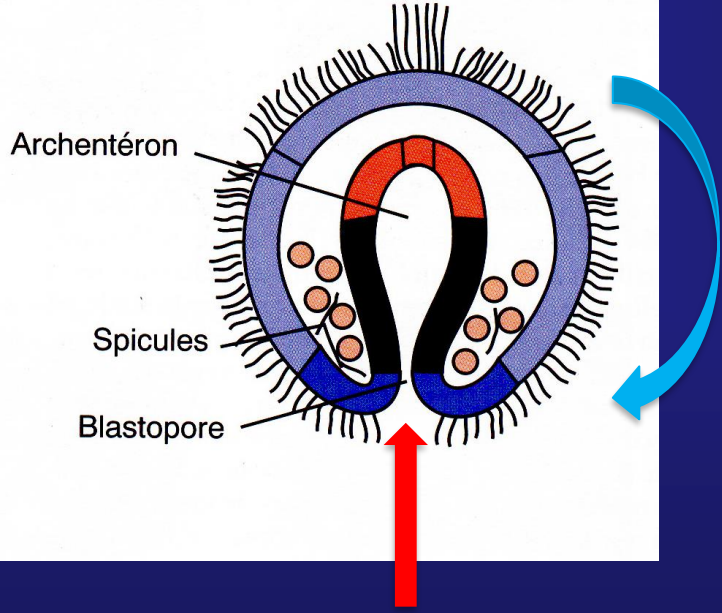
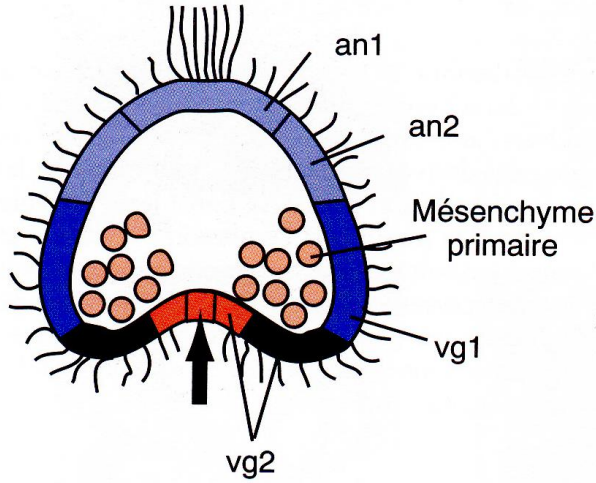
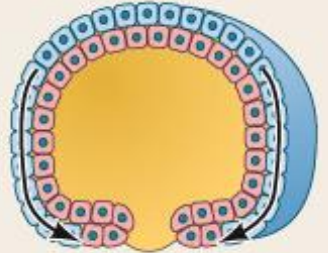
Invagination

Infolding of a sheet (epithelium) of cells, much like the indentation of a soft rubber ball when it is poked.



Epiboly

Movement of epithelial sheets (usually ectodermal cells) spreading as a unit (rather than individually) to enclose deeper layers of the embryo. Can occur by cells dividing, by cells changing their shape, or by several layers of cells intercalating into fewer layers; often, all three mechanisms are used.



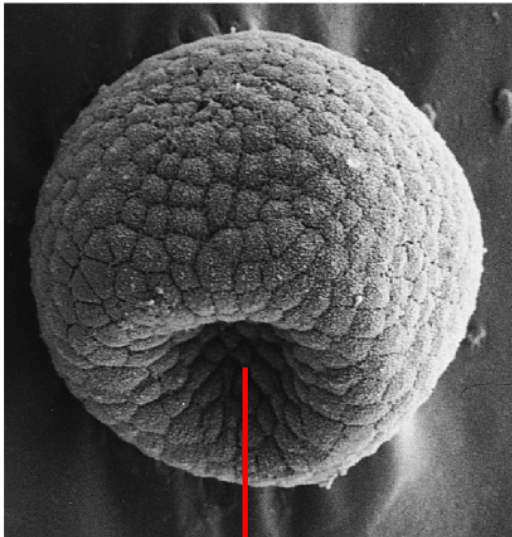
Invaginazione

Epibolia

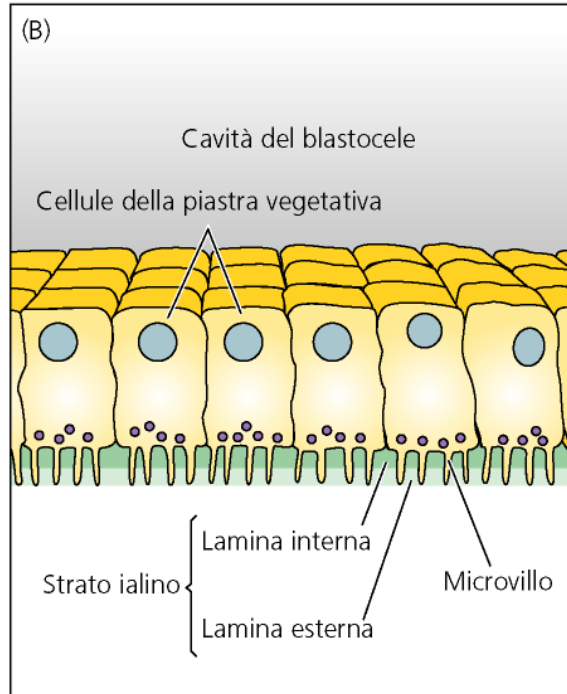
Invaginazione delle cellule derivate dai macromeri  
Epibolia dell'ectoderma

# Meccanismi del movimento di invaginazione: cause estrinseche

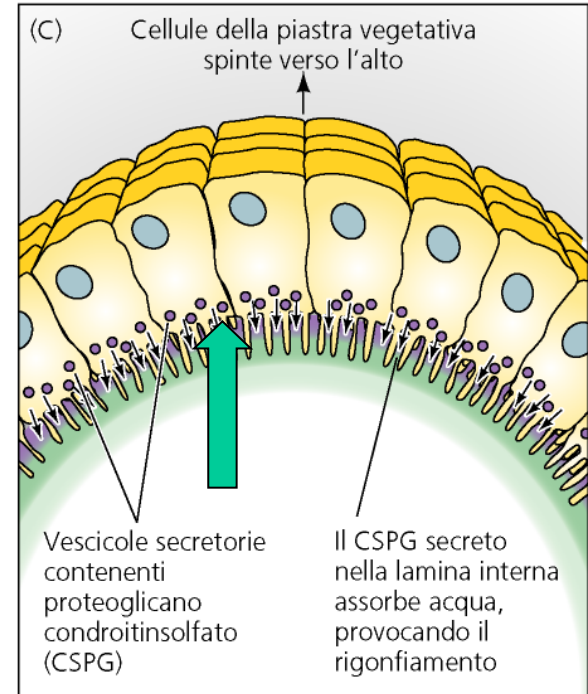
(A)



(B)



(C)

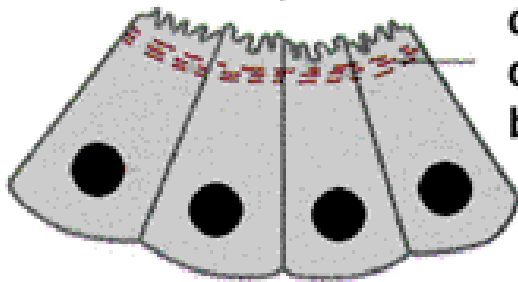
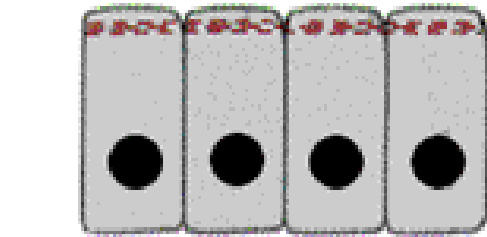


**Blastoporo**

- deposizione di proteoglicani nello strato ialino
- rigonfiamento dello strato ialino

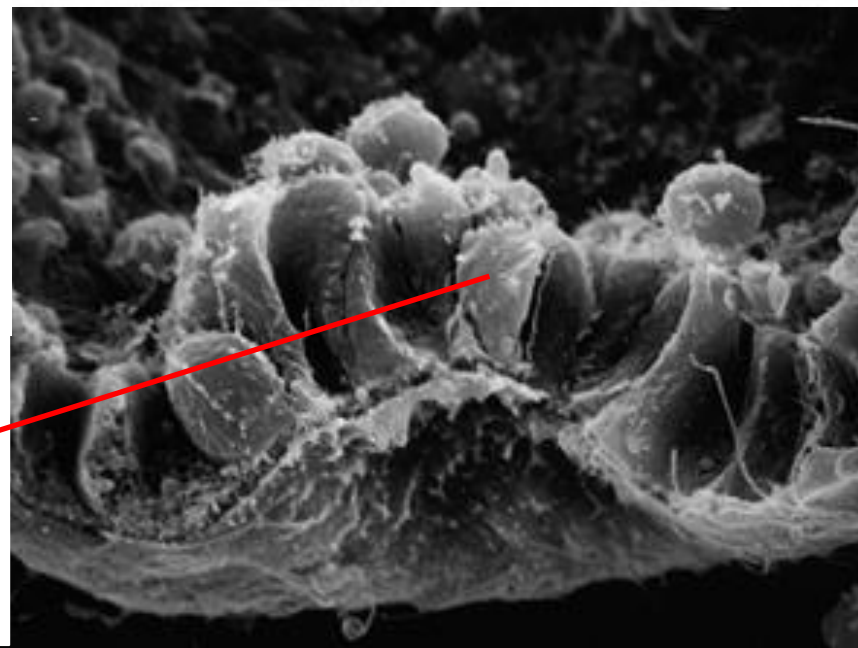
# Meccanismi del movimento di invaginazione: cause intrinseche

## Apical Constriction and Invagination

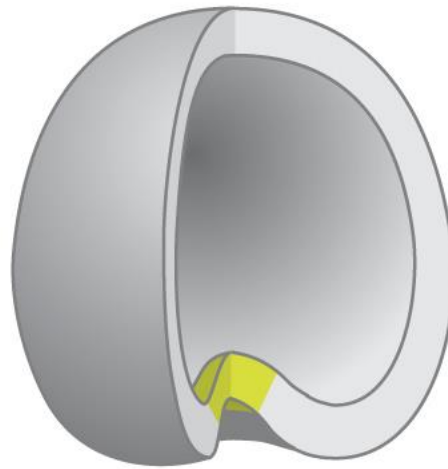
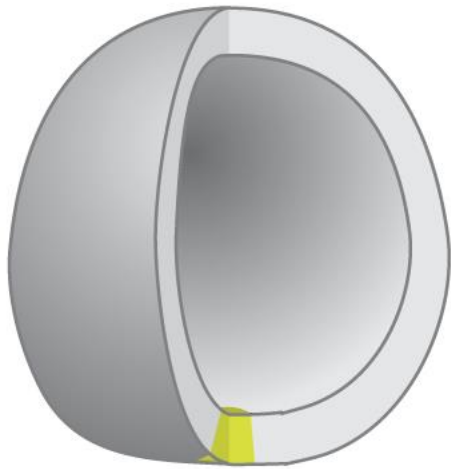


apical actomyosin complex undergoes contraction to buckle epithelium

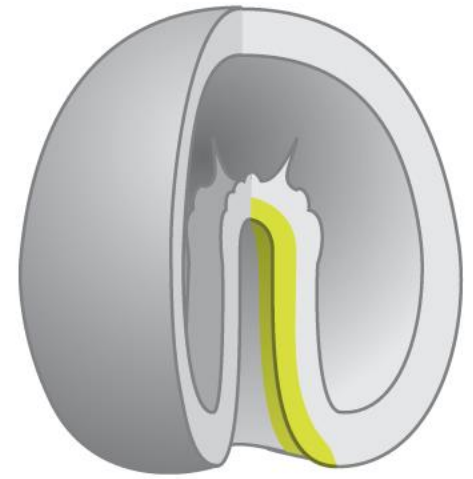
Cellule a cuneo



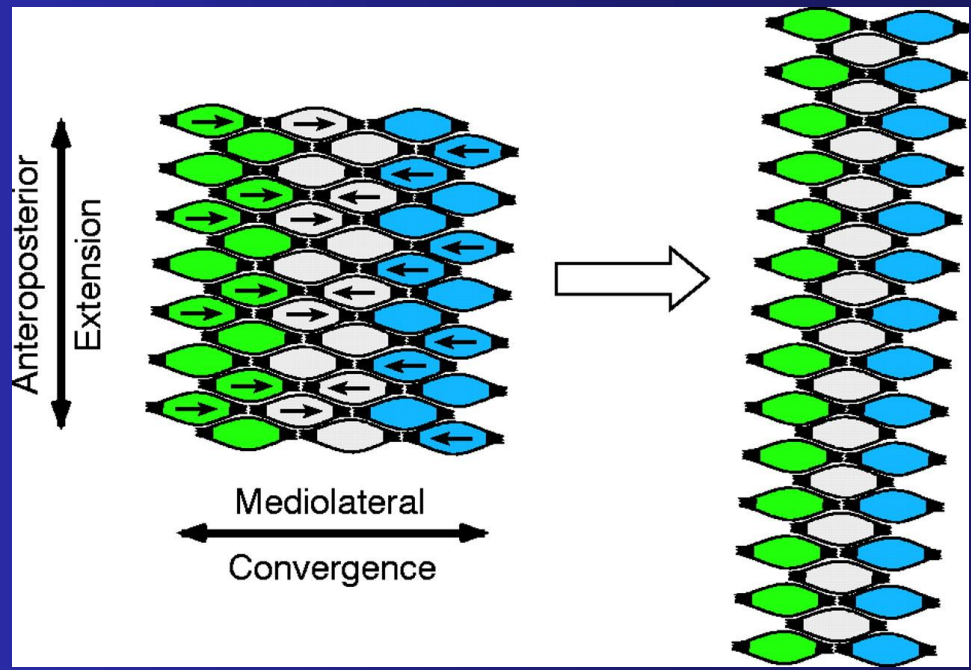
Blastula



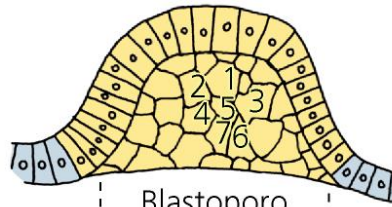
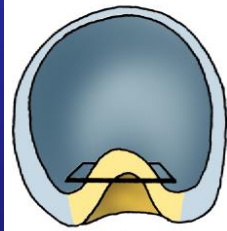
Gastrula



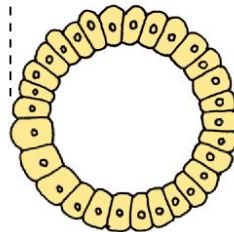
**Meccanismi di formazione dell'archenteron: movimento di estensione convergente causato da processi di intercalazione medio-laterale**



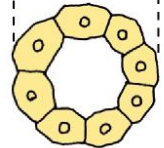
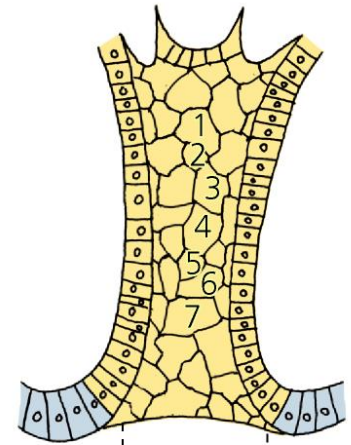
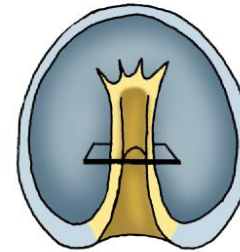
GASTRULAZIONE INIZIALE



Blastoporo



GASTRULAZIONE AVANZATA



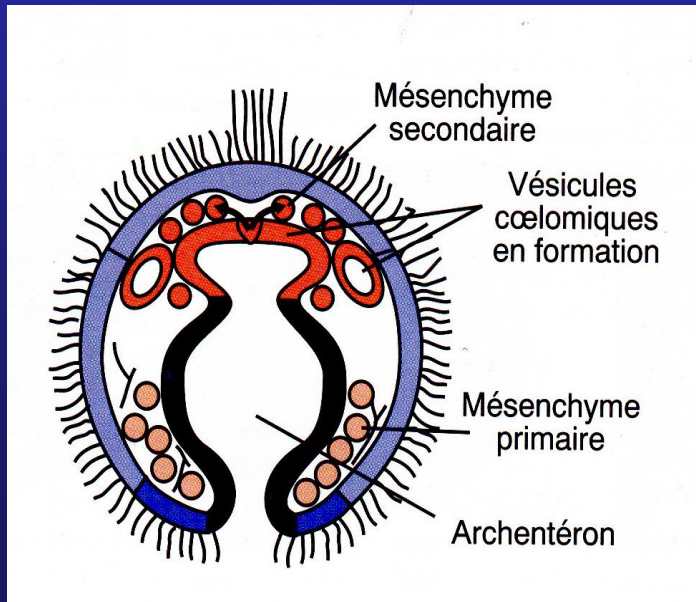
# Meccanismi di formazione dell'archenteron: ruolo del mesenchima secondario

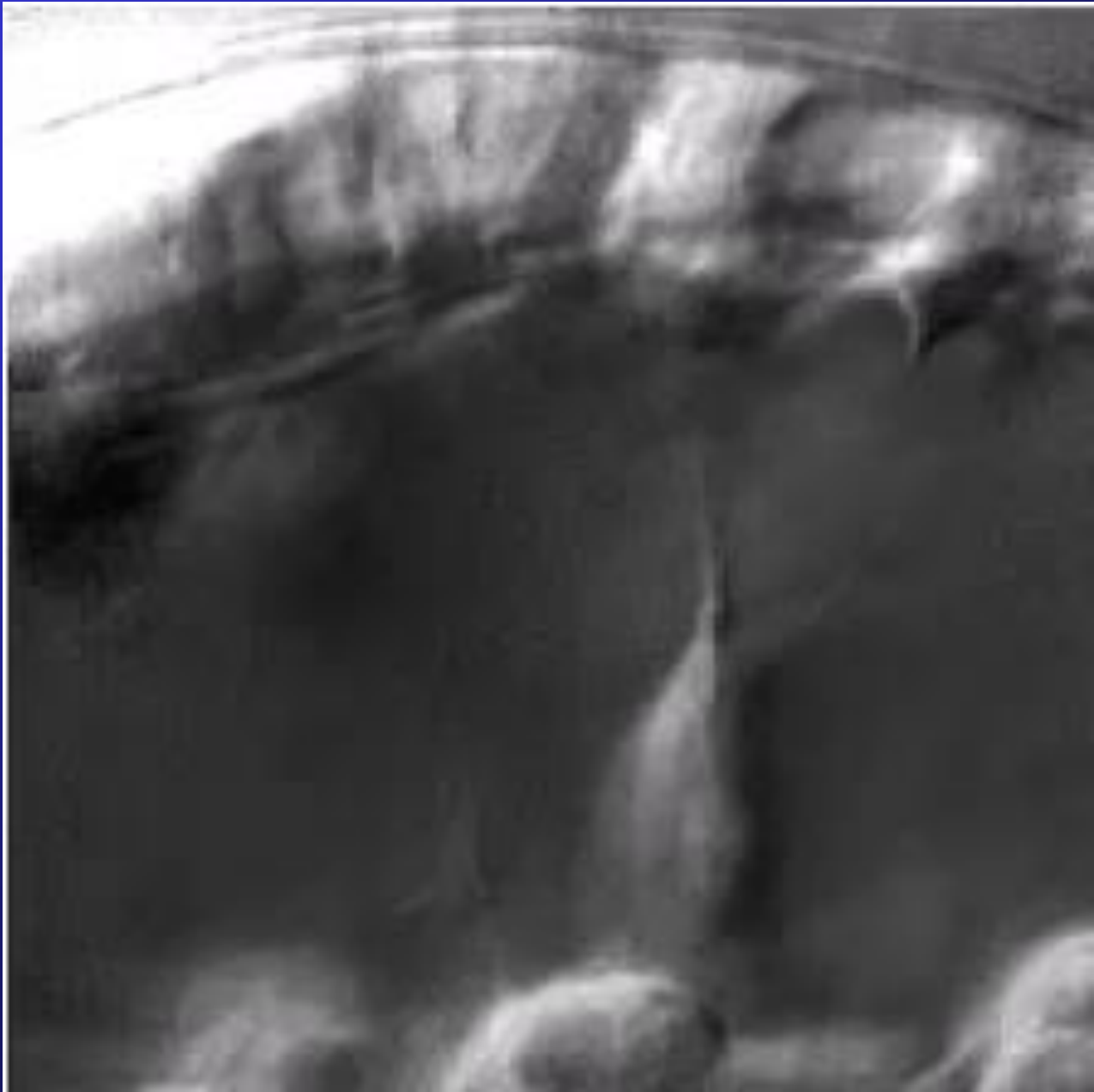


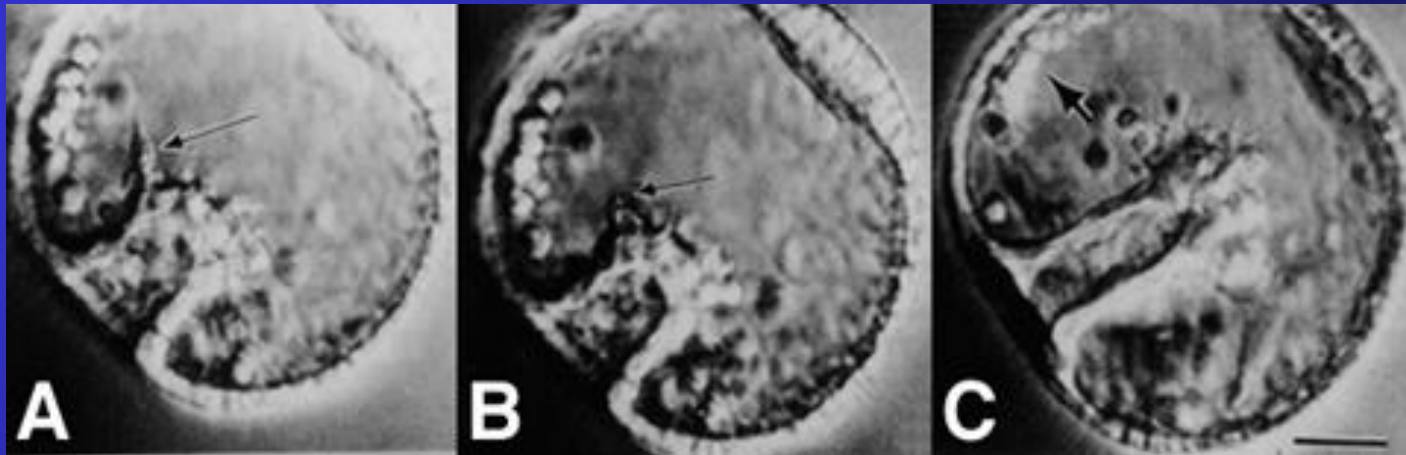
Vescicole celomatiche

Muscolatura larvale

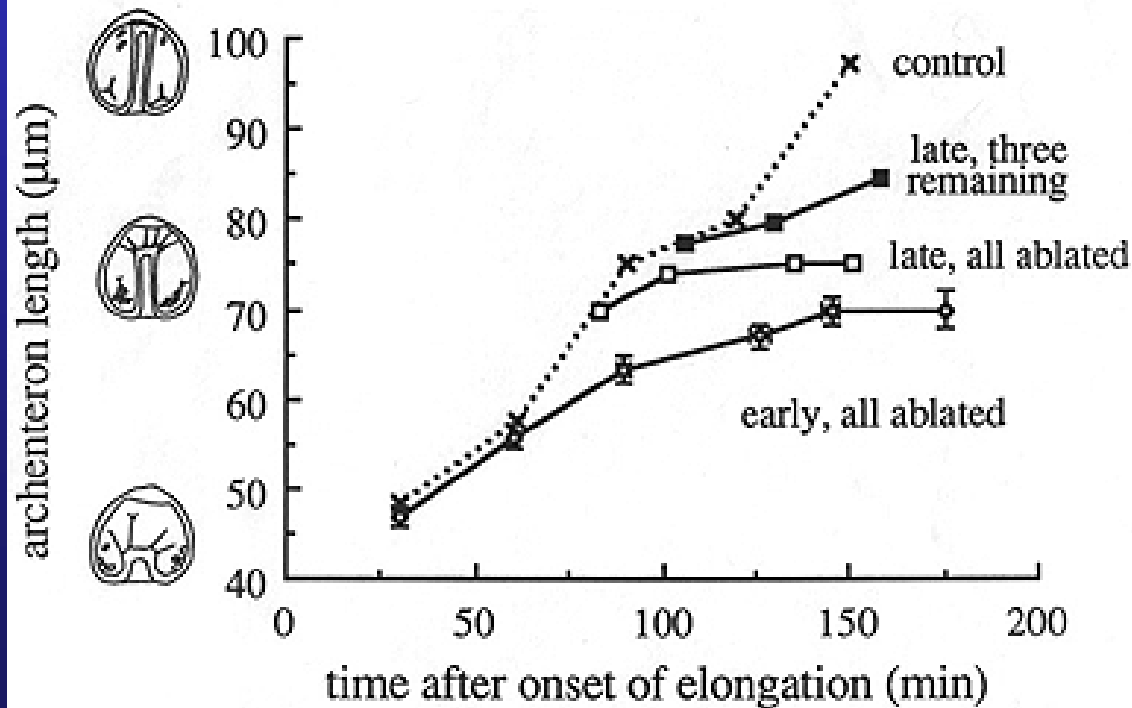
Contribuisce al contatto tra archenteron  
e la regione dello stomodeo (bocca)  
tramite contrazione di filopodi

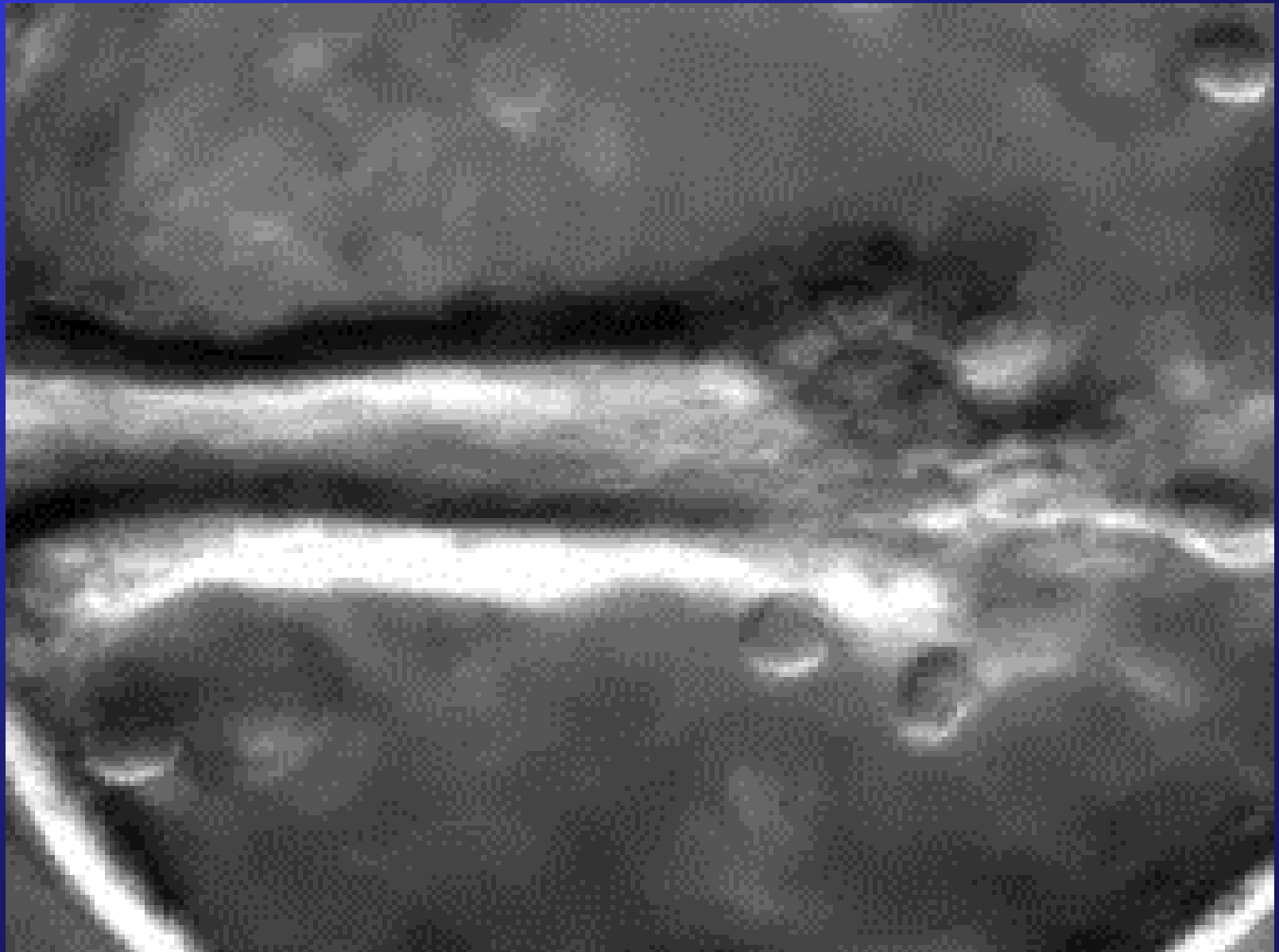




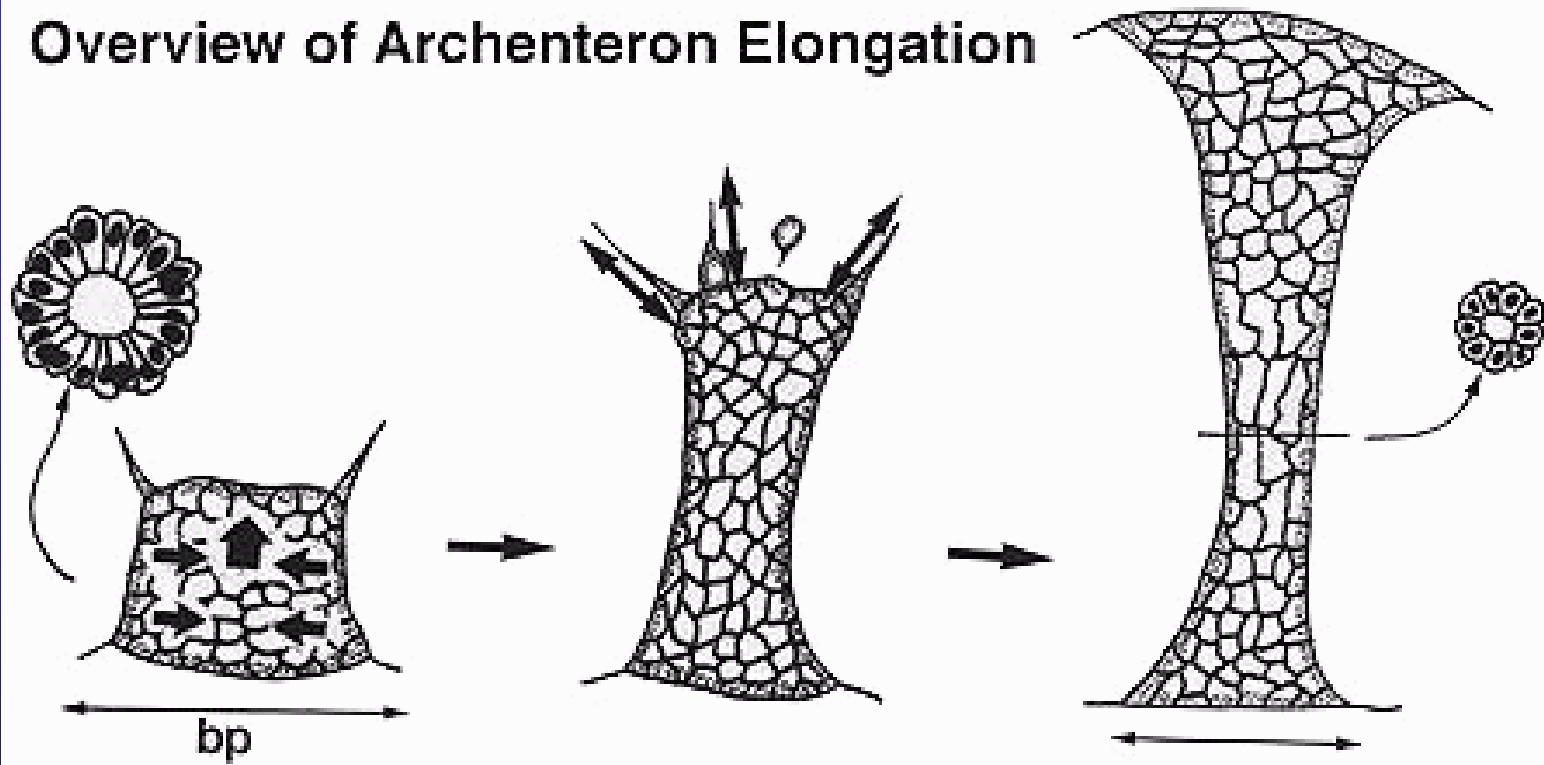


### SMCs are Required Late in Gastrulation



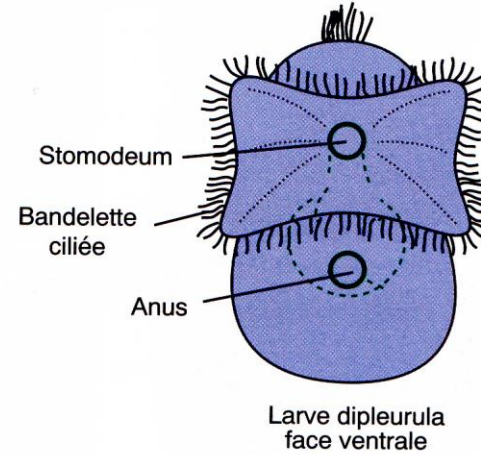
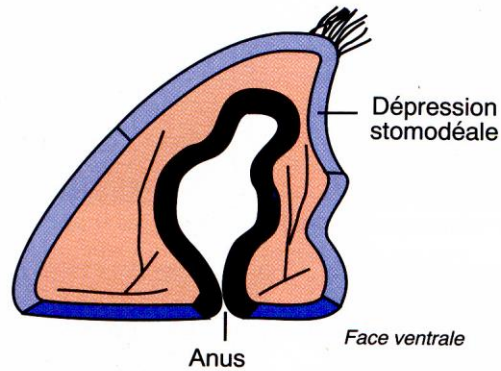


## Overview of Archenteron Elongation

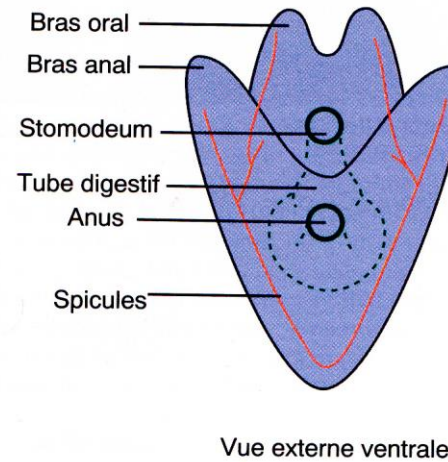
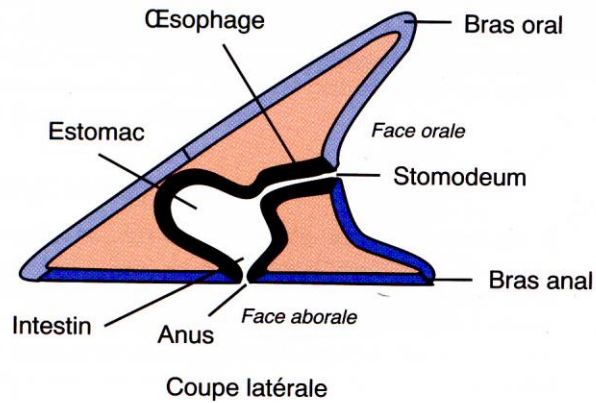


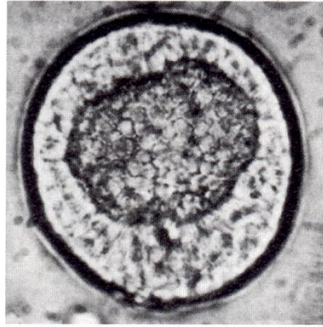
# Formazione della larva pluteo

Formation de la larve pluteus

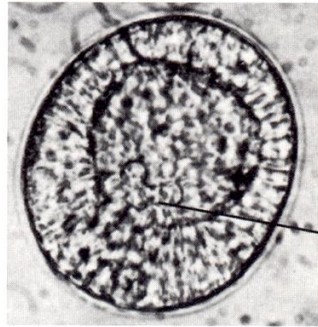


Larve pluteus

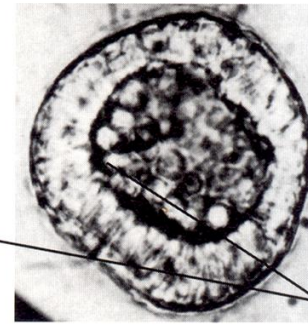




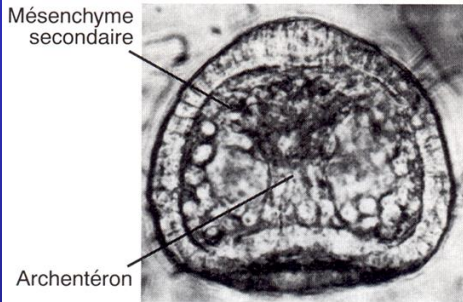
Blastula nageuse



Gastrula avec mésenchyme primaire

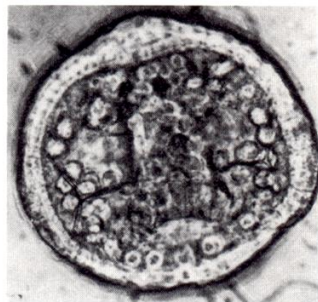


Mésenchyme primaire

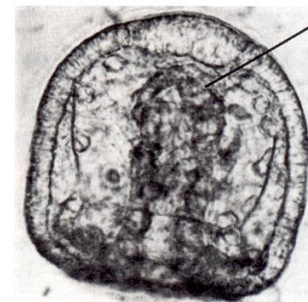


Mésenchyme secondaire

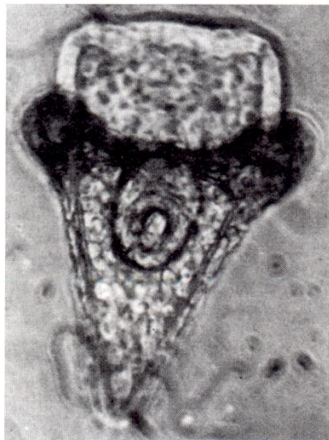
Archentéron



Gastrula avec archentéron et mésenchyme secondaire



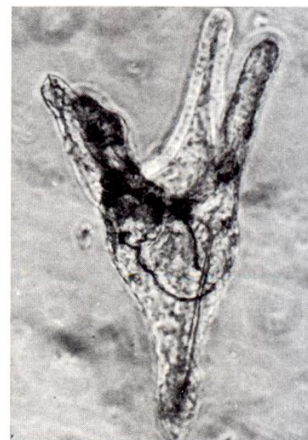
Vésicules cœlomiques

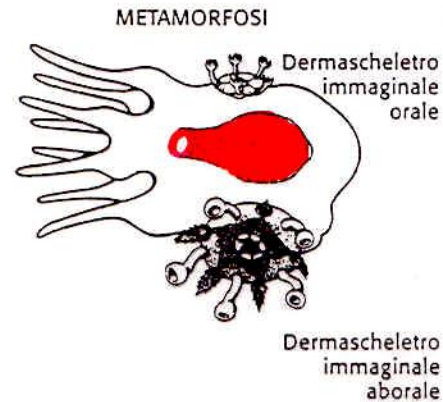
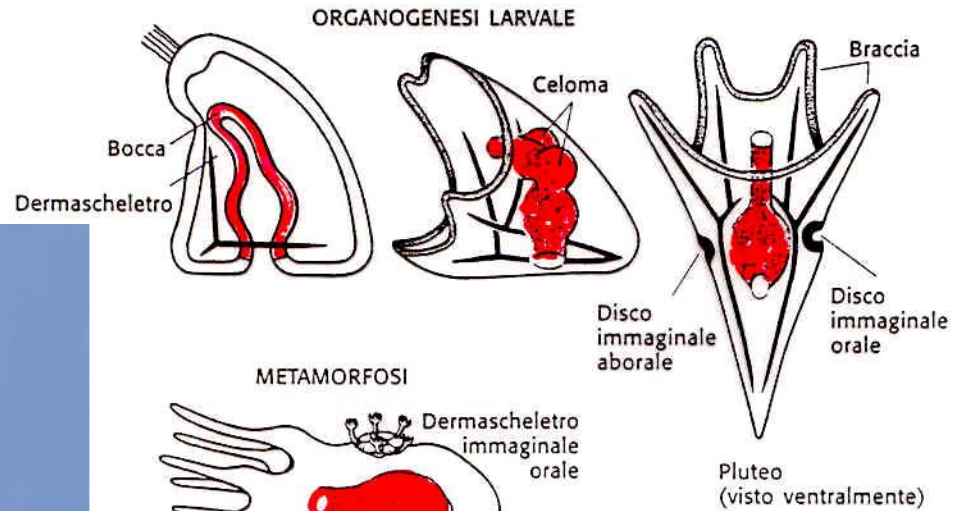
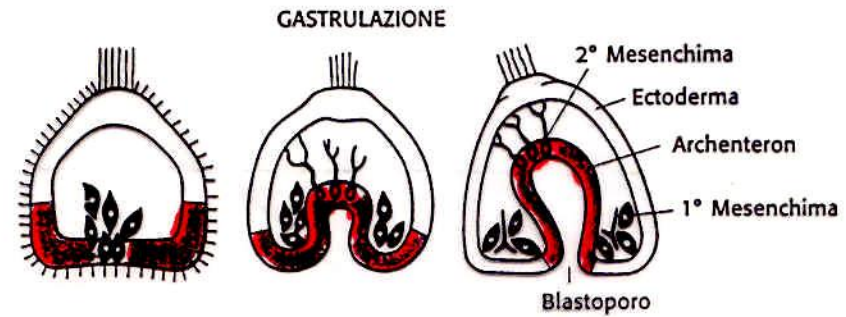


Jeune pluteus  
vue ventrale



Pluteus âgées en vues ventrale et latérale





Rudimento immaginale

Sviluppo dell'embrione di riccio di mare. Parte seconda: dalla gastrulazione all'inizio della metamorfosi. La gastrulazione avviene in diverse fasi e produce la cavità interna con cellule dalle quali si originano gli organi interni. La larva risultante è chiamata pluteo. È rappresentato uno solo degli stadi che partono dalla metamorfosi della larva, a simmetria bilaterale, per arrivare al riccio di mare adulto, a simmetria pentaraggiata.